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U.S. Army Environmental Center

Final Remedial Investigation Sampling Plan Addendum

Milan Army Ammunition Plant Remedial Investigation Southern Study Area (Operable Unit No. 5)

Contract Number DAAA15-91-D-0012
Task Order Number 0007
Data Item A004

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Disclaimer Statement

EXECUTIVE SUMMARY

Introduction

This sampling plan addendum was developed to provide additional field data necessary to address environmental regulatory comments regarding the "Draft Milan Army Ammunition Plant (MLAAP) Remedial Investigation, Southern Study Area (Operable Unit No. 5)" prepared by Fluor Daniel, Inc. (Fluor Daniel) in March 1996. The report was distributed through the MLAAP to federal and state environmental regulators under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) Federal Facility Agreement and Consent Order (FFA) currently in affect at the site. Review comments were received from the U.S. Environmental Protection Agency (USEPA) and the State of Tennessee Department of Environment & Conservation (TDEC) in January 1997 and July 1996, respectively. The majority of comments raised by the regulators focused on the need for additional technical clarification or references to support report conclusions. However, some additional field data is necesary to fully address regulatory comments. Response to comments and submittal of a revised remedial investigation (RI) report will be provided following completion of field activities specified in the sampling plan addendum. This addendum also provides additional data requested by the MLAAP to support the ongoing feasibility study being conducted by QST Environmental (formerly Environmental Science & Engineering, Inc. (ESE)).

The draft remedial investigation report characterized the nature and extent of risks posed by contamination present within the MLAAP Southern Study Area, and provided data to support the evaluation of potential remedial cleanup options (as necessary). The report presented background research results, field investigation procedures, field investigation results, contaminant fate and transport evaluation results, and baseline risk assessment results pertaini ng to human health and environment. However, additional characterization is required to better quantify risks in accordance with CERCLA (Superfund) requirements. Additional field work needed include:

- Off-site groundwater quality - Existing chemical sampling & analysis results from off-site wells will be evaluated to assist in determining groundwater transport of nitrobodies from the MLAAP Southern Study Area.

- Contaminant source surface soil sampling - Sampling & analysis of surface soil from the Open Burning Ground in Areas "B", "D", "F", "G", and "J"; and areas immediately outside of Area "B" where ordnance debris was resently observed for nitrobodies and selected heavy metals.

- Contaminant source sub-surface soil sampling - Sampling & analysis of sub-surface soil from the Open Burning Ground in Areas "F" (disposal trenches), and other areas indicating elevated surface soil contamination from the soil sampling & analysis effort for nitrobodies and selected heavy metals.

- Groundwater monitoring well/lysimeter installions - Installation of three (3) monitoring wells and four (4) nested lysimeters, and subsequent sampling and analysis for

nitrobodies and selected heavy metals to better define unsaturated and saturated groundwater contaminantion eminating from the Open Burning Ground.

- Surface water & sediment sampling - Sampling & analysis of the Halls Branch of Johns Creek down stream from Ditch 9 (drainage from the Open Burning Ground) for nitrobodies and selected heavy metals.

Details regarding justification of planned field activities and technical methodologies are presented in the sampling plan addendum.

Fluor Daniel was contracted by the U.S. Army Environmental Center, (USAEC) (formerly the U.S. Army Toxic & Hazardous Materials Agency, (USATHAMA)) to conduct the investigation under Contract No. DAAA15-91-D-0012, Task Order No. 0007. Task Order No. 0007 was issued to Fluor Daniel on September 22, 1993.

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Acronyms

Ammunition Destruction Area (ADA)

Ammunition Test Area (ATA)

below ground surface (bgs)

Christensen Boyles Corporation (CBC)

"clbr_u" - Claiborne Formation (Memphis Sand - upper aquifer)

"clbr_m" - Claiborne Formation (Memphis Sand - middle aquifer)

"clbr_d" - Claiborne Formation (Memphis Sand - deep aquifer)

Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA)

Defense Reutilization and Marketing Service (DRMS)

degrees Centigrade (°C)

degrees Fahrenheit (°F)

Department of the Army (DA)

Environmental Hazards Specialists International, Inc. (EHSI)

engineering evaluation/cost analysis (EE/CA)

Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual (ECBSOPQAM)

Environmental Protection Agency, Region IV (EPA)

Environmental Resources Management, Inc. (ERM)

Environmental Science and Engineering, Inc. (ESE)

Evaluations/Cost Analyses (EE/CA)

Explosives Ordnance Disposal (EOD)

Federal Facility Agreement and Consent Order (FFA)

feet above mean sea level (ft-msl)

Fluor Daniel, Inc. (Fluor Daniel

Fluor Daniel (FD)

gallons per minute (gpm)

Genral Dynamics Ordnance Systems, Inc. (GDOS)

geo-synthetic clay liner (GCL)

granular activated carbon (GAC)

Health Advisories (HAs)

Health/Sciences Consulting (HSC)

Investigation derived waste (IDW)

Lead (Pb)

Lockheed Martin Ordnance Systems, Inc. (LMOS)

Martin Marietta Ordnance Systems, Inc. (MMOS)

Maximum Contaminant Level (MCL)

Maximum Contaminant Level Goal (MCLG)

microgram per gram ($\mu g/g$)

microgram per liter ($\mu g/l$)

Midwest Research Institute (MRI)

Milan Army Ammunition Plant (MLAAP)

Milan Ordnance Depot (MOD)

miles per hour (mph)

milligram per kilogram (mg/kg)

milligrams per liter (mg/l)

million electron volts (MEV)

National Oil and Hazardous Substances Pollution Contingency Plan under CERCLA (NCP)

National Primary Drinking Water Standards (NPDWS)

National Priorities List (NPL)

Omega Environmental Services, Inc. (OES)

Open Burning Ground (OBG)

Operable Unit (OU)

parts per million (ppm)

percent (%)

pink water treatment facilities (PWTFs)

Preliminary Remediation Goals (PRGs)

quality assurance/quality control (QA/QC)

remedial investigation (RI)

Resource Conservation and Recovery Act of 1976 (RCRA)

Scope of Work (SOW)

Secondary Maximum Contaminant Level (SMCL)

Small Business Administration (SBA)

solid waste management unit (SWMU)

solubility product (K_{sp})

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Tennessee Army National Guard (TANG)

Tennessee Department of Environmental Control (TDEC), Division of Solid Waste Management (DSWM)

"to be considered" (TBC)

Toxicity Characteristic Leaching Procedure (TCLP)

Quality assurance/quality control (QA/QC)

unexploded ordnance (UXO)

U. S. Army Armament, Munitions and Chemical Command (USAMCCOM)

U.S. Army Corps of Engineers (USACOE)

U.S. Army Environmental Center (USAEC)

U.S. Army Toxic & Hazardous Materials Agency (USATHAMA)

U.S. Environmental Protection Agency (USEPA)

Wolf Creek Ordnance Plant (WCOP)

1.0 INTRODUCTION

The sampling plan addendum was developed to provide additional field data necessary to address environmental regulatory comments regarding the Draft MLAAP RI Southern Study Area (Operable Unit No. 5) Report prepared by Fluor Daniel, Inc. (Fluor Daniel) in March 1996. The report was distributed through the MLAAP to federal and state environmental regulators under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) Federal Facility Agreement and Consent Order (FFA) currently in affect at the site. Review comments were received from the USEPA and the TDEC in January 1997 and July 1996, respectively. The majority of comments raised by the regulators focused on the need for additional technical clarification or references to support report conclusions. However, some additional field data is necessary to fully address regulatory comments. Response to comments and submittal of a revised (draft final) RI report will be provided following completion of field activities specified in the sampling plan addendum. This addendum also provides additional data requested by the MLAAP to support the ongoing feasibility study conducted by Environmental Science & Engineering, Inc. (ESE).

Fluor Daniel team members involved in the MLAAP RI for the Southern Study Area (Operable Unit No. 5) addendum effort include the following:

- Fluor Daniel - Prime contractor responsible for the overall RI effort. Fluor Daniel was responsible for project management, planning, quality assurance/ quality control (QA/QC), field program activities, sample collection, data management, documentation, and technical reporting.

- Health/Sciences Consulting (HSC) - Baseline risk assessment modification (if necessary) including human health evaluation and environmental evaluation.

- QST Environmental (formerly Environmental Science and Engineering, Inc. (ESE)) - Chemical analytical laboratory responsible for chemical analysis of environmental samples, QA/QC, and data management.

- Environmental Hazards Specialists International, Inc. (EHSI) - Site clearance support for unexploded ordnance, field support, and explosive ordnance disposal (EOD) screening support. MLAAP personnel conducted actual EOD operations when UXO were identified by EHSI personnel.

- Christensen Boyles Corporation (CBC) - Drilling operations, monitoring well installations, and other field activities.

General Dynamics Ordnance Systems, Inc. (GDOS) (MLAAP operating contractor) personnel will assist Fluor Daniel through the USAEC and MLAAP by providing field support, on site chemical analytical support, and disposal of investigation derived waste (IDW).

The field sampling plan addendum serves as a field manual during the data collection program for the MLAAP RI Southern Study Area. The addendum is a component of the MLAAP RI

Southern Study Area Project Plans that document, in detail, the technical approach for the task order. Field activities will be performed in accordance with requirements documented in these plans (previously submitted and approved by USEPA and TDEC). In total, the project plans consist of the following documents:

- RI Technical Work Plan,
- RI Field Sampling Plan,
- RI Quality Assurance Project Plan,
- RI Health & Safety Plan, and
- RI Data Management Plan.

Fluor Daniel was contracted by the U.S. Army Environmental Center (USAEC) (formerly the U.S. Army Toxic & Hazardous Materials Agency (USATHAMA)) to conduct a Remedial Investigation (RI) of the Milan Army Ammunition Plant (MLAAP) Southern Study Area (Operable Unit No. 5). The RI is being performed under Contract No. DAAA15-91-D-0012, Task Order No. 0007. Contract administration was originally under the U. S. Army Armament, Munitions and Chemical Command (USAMCCOM); however, effective March 3, 1995 was transferred to the U.S. Army Corp of Engineers, Baltimore District. Task Order No. 0007 was issued to Fluor Daniel on September 22, 1993.

2.0 FIELD SAMPLING PROGRAM RATIONALE

The objective of the field sampling plan addendum is to address data needs as determined from a review of environmental regulatory comments regarding the Draft MLAAP RI Southern Study Area (Operable Unit No. 5) Report, and to provide necessary data to complete the ongoing feasibility study being conducted by ESE. Sample media, chemical analytes, and locations have been selected based review of regulatory comments, draft RI report findings, and technical input for ESE.

The majority of field activities focus on selected contaminant sites located within the Open Burning Ground, and the former Ammunition Destruction Area. Major contamination was identified within these areas that have affected soil, sediment, surface water, and groundwater matrices. Additional field data is necessary to quantify transport mechanisms that resulted in groundwater contamination by nitrobodies in these locations. In addition, addition sampling activities for data necessary to address TDEC comments and ongoing feasibility study activities are provided.

2.1 Site Background

Site background data is provided in the Draft MLAAP RI Southern Study Area (Operable Unit No. 5) Report (Chapter 2.0) and is not repeated in this addendum. Discussions regarding site physical setting, site history, description of past & ongoing operations, previous investigations, and data evaluation of those investigations are included in the draft report. Pertinent items from those discussions are provided in this addendum to support field sampling rationale.

The majority of field activities in this addendum involve the Open Burning Ground, which was identified as the major source of contamination within the site. Detailed discussion is provided with summaries of pertinent technical data to support field activities identified in this section.

2.2 Description of MLAAP Southern Study Area

The Southern Study Area of MLAAP includes all property south of Route 54 that crosses the Plant in an east-west direction. Sites within the study area that are addressed under the RI include:

- Open Burning Ground,
- Former Ammunition Destruction Area,
- Current Ammunition Destruction Area,
- Ammunition Test Area,
- Ammunition Storage Area,
- Closed Ammunition Burnout Area, and
- Sanitary Landfill.

The Open Burning Ground (OBG), the former Ammunition Destruction Area (ADA), and current ADA are collectively known as Area "W". Potential contaminant sites and formal area designations within the MLAAP Southern Study Area are presented (Figures 2-1 (a) & (b)) and

Table 2-1) for orientation purposes. Detailed descriptions of the OBG and former ADA are provided since additional field investigations are proposed for these sites.

2.2.1 Open Burning Ground

The OBG is located in Area "W" and is thought to have been in use since the beginning of operations at the MLAAP in 1942. No permanent written records regarding the OBG were maintained by the Plant; however, interviews documented in previous investigations and discussions with Plant personnel provide an adequate description of past and current activities at the site. The OBG consists of approximately 180 acres and has been used for the destruction and disposal of reject munitions and explosives-contaminated wastes. Various types of munitions produced at the MLAAP (Table 2-2), or their components may have been discarded in the OBG. Technical data relating to the various munitions are documented in the DA Explosive Content Manual. This manual provides a listing of the ammunition type, components, and the amount and type of explosive or propellant used in each component. Although quantities of munitions, or their components cannot be determined from this manual, potential contaminants of concern were identified.

Operations at the OBG were reconstructed from plant personnel interviews conducted prior to this RI. Results of the interviews indicated that three categories of wastes have been disposed at the OBG since 1942. These include bulk explosives, ordnance components, and wastes potentially contaminated with explosives. Bulk explosives included large quantities of explosives not containerized in munitions, ordnance components consisted of defective ordnance or their components damaged during assembly at MLAAP or removed from storage facilities, and explosives-contaminated wastes consisted of various solid wastes. The solid waste includes boxes, crates, paper, rags, strapping, pallets, paints, granular-activated carbon, and cleaning solvents that may have been in contact with explosive materials. Bulk explosives were burned on the ground surface, with the resulting ash disposed in natural gullies or excavated trenches. Occasionally, burning explosives were observed to detonate, resulting in earthen craters. A few reports indicate that bulk explosives may have been buried in trenches at the OBG. Ordnance items and explosive contaminated wastes were routinely discarded in trenches at the OBG with ash from the burning of bulk explosives. These materials were then burned when a sufficient quantity was accumulated in the trenches. During these burning operations, ordnance items or components were observed to detonate on an infrequent basis, broadcasting ordnance (known as "kickouts") into the surrounding areas. Liquids potentially contaminated with explosives, including paints and cleaning solvents, were discarded into a group of trenches without burning. Trench locations in the OBG were selected based upon site access and topography. Trench excavations were typically made using a bulldozer excavating into a hillside, with the entrance located at the toe of the hillside. These trenches are reported to be not deeper than 15 feet and usually a single bulldozer blade width at the base of the excavation. Debris, ordnance, and ash were dumped from trucks at the sides of the trenches, beginning at the up slope end. The trench contents were burned periodically until the excavation was filled and then covered with soil.

OBG operations changed in late 1983 due to RCRA and Tennessee Hazardous Waste Rules. The TDEC (formerly the Tennessee Department of Health) required MLAAP to cease burning of explosive contaminated (reactive) wastes on the ground surface. MLAAP modified the burning

Figure 2-1 (a). MLAAP RI Southern Study Area Potential Contaminant Sites

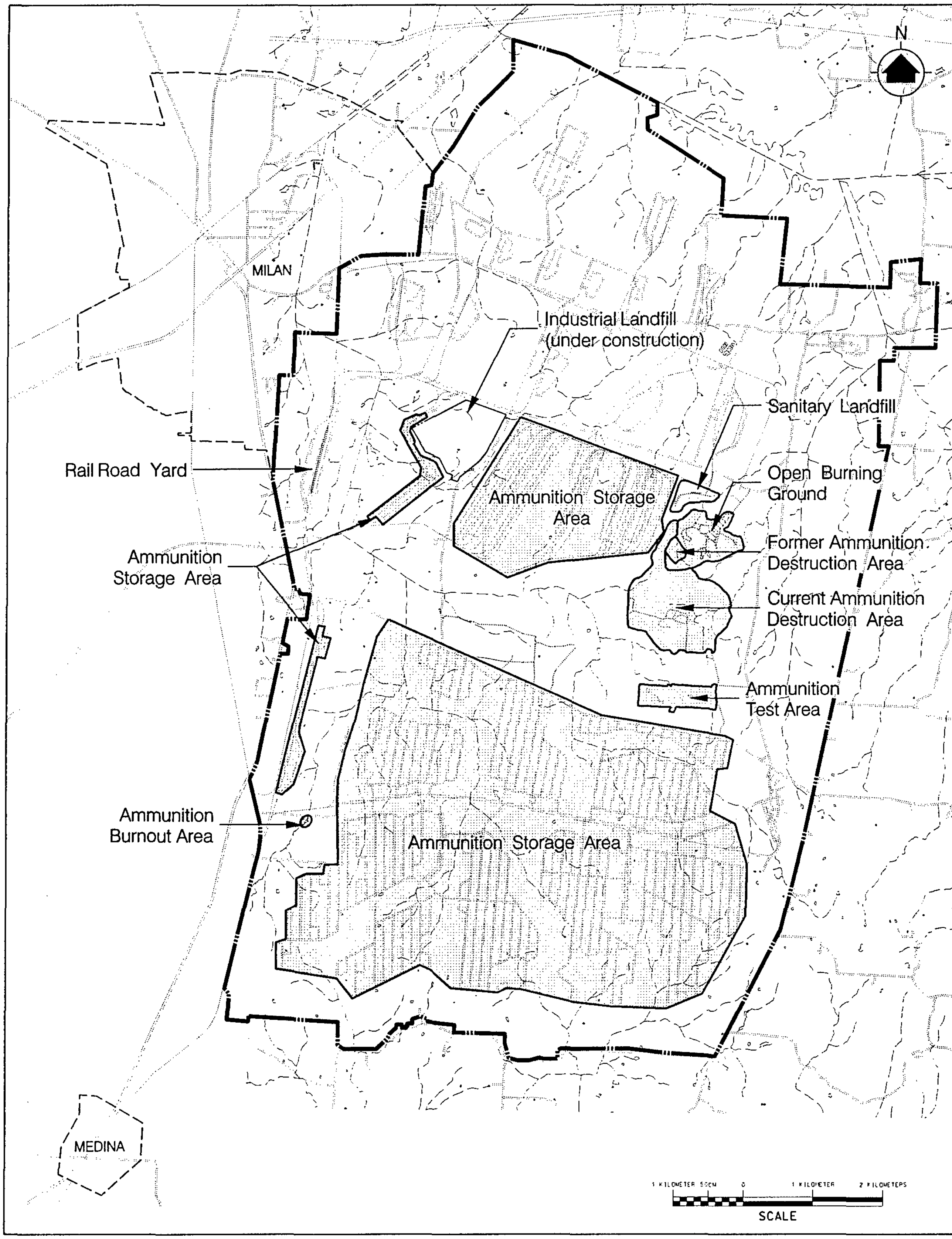


Figure 2-1 (b). MLAAP RI Southern Study Area Formal Area Designations

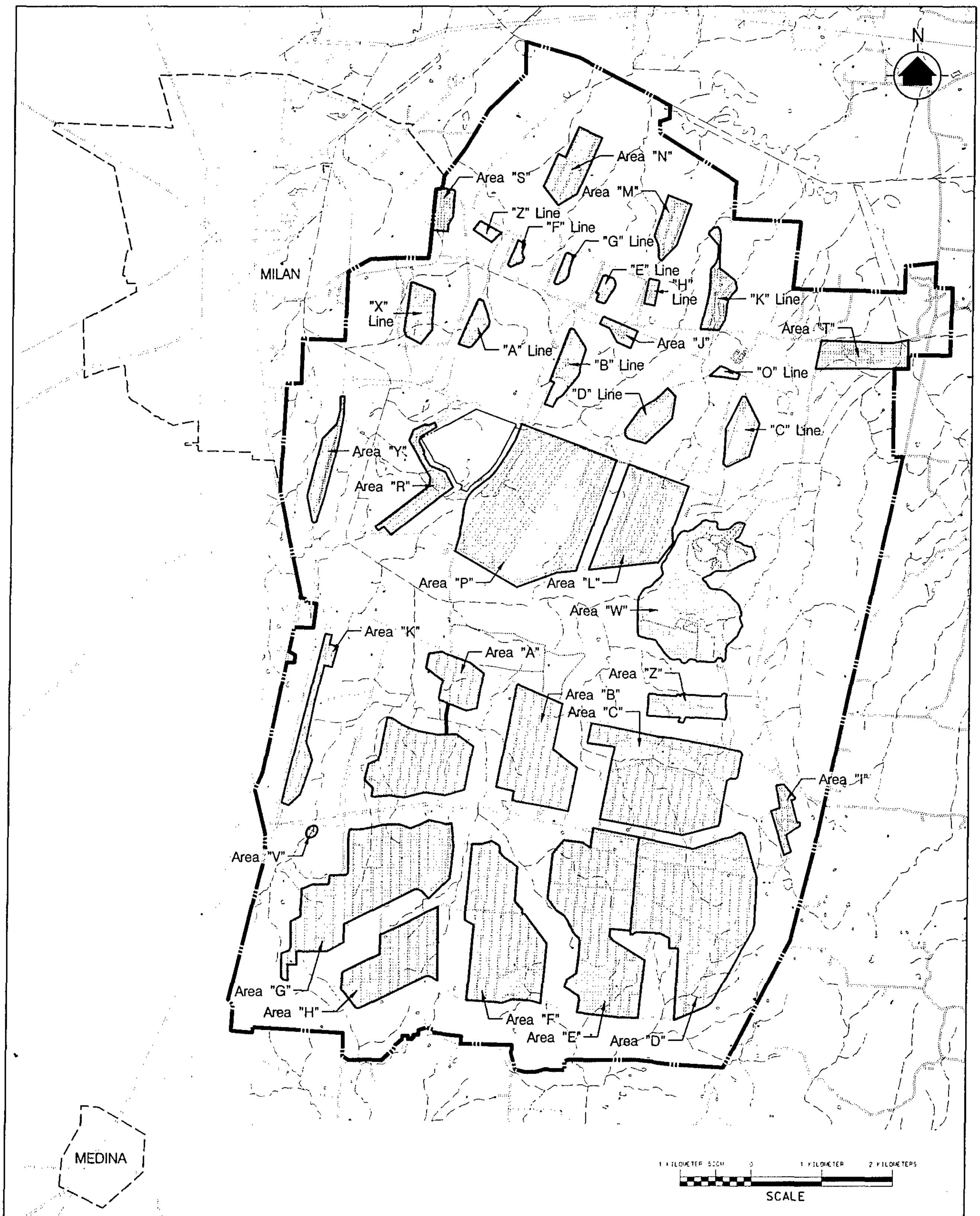


Table 2-1. MLAAP RI Southern Study Area
Formal Area Designations

Area	Description
"A"	Ammunition storage area with total number of storage igloos for "field service explosive storage": 89. Storage igloos consist of earth covered, arch type steel reinforced concrete serviced by rail and truck. Stored material consists of Class IV & V finished ammunition including primers and fuzes.
"B"	Ammunition storage area with total number of storage igloos for "field service explosive storage": 78. Storage igloos consist of earth covered, arch type steel reinforced concrete serviced by rail and truck. Stored material consists of Class IV & V finished ammunition including projectiles and 105 mm cartridges.
"C"	Ammunition storage area with total number of storage igloos for "field service explosive storage": 97. Storage igloos consist of earth covered, arch type steel reinforced concrete serviced by rail and truck. Stored material consists of Class IV & V finished ammunition including 40 mm and 60 mm shells, and mortar rounds.
"D"	Ammunition storage area with total number of storage igloos for "field service explosive storage": 100. Storage igloos consist of earth covered, arch type steel reinforced concrete serviced by rail and truck. Stored material consists of Class IV & V finished ammunition including mortar rounds. Permitted Category II hazardous waste storage also contained within area.
"E"	Ammunition storage area with total number of storage igloos for "field service explosive storage": 98. Storage igloos consist of earth covered, arch type steel reinforced concrete serviced by rail and truck. Stored material consists of Class IV & V finished ammunition.
"F"	Ammunition storage area with total number of storage igloos for "field service explosive storage": 94. Storage igloos consist of earth covered, arch type steel reinforced concrete serviced by rail and truck. Stored material consists of Class IV & V finished ammunition.
"G"	Ammunition storage area with total number of storage igloos for "field service explosive storage": 92. Storage igloos consist of earth covered, arch type steel reinforced concrete serviced by rail and truck. Stored material consists of Class IV & V finished ammunition.
"H"	Ammunition storage area with total number of storage igloos for "field service explosive storage": 54. Storage igloos consist of earth covered, arch type steel reinforced concrete serviced by rail and truck. Stored material consists of Class IV & V finished ammunition.
"I"	Ammunition storage area with total number of storage buildings for "field service inert (non-explosive) storage": 3. Storage buildings consist of 14 foot high, fireproof tile block with steel framing, wood decking, and shingled roof structures serviced by rail and truck. Stored material consists of inert material only.
"K"	Ammunition storage area with total number of storage buildings for "field service explosive storage": 8. Storage buildings consist of 14 foot high, fireproof tiles with corrugated asbestos cement roof structures serviced by rail and truck. Stored material consists of finished ammunition, hazard class 1.2 through 1.4.
"L"	Ammunition storage area with total number of storage igloos for "industrial explosive storage": 40. Storage igloos consist of earth covered, arch type steel reinforced concrete serviced by rail and truck. Stored material consists of various explosive compounds (i.e., 246TNT, RDX, & HMX) and propellants.
"P"	Ammunition storage area with total number of storage igloos for "industrial explosive storage": 88. Storage igloos consist of earth covered, arch type steel reinforced concrete serviced by rail and truck. Stored material consists of various explosive compounds (i.e., 246TNT, RDX, & HMX) and propellants.
"R"	Ammunition storage area with total number of storage buildings for "field service explosive storage": 14. Storage buildings consist of 14 foot high, fireproof tiles with corrugated asbestos cement roof structures serviced by rail and truck. Stored material consists of finished ammunition (hazard class 1.2 through 1.4) and inert material.
"V"	Site of the Closed Ammunition Burnout Area (also known as the Sunny Slope area) that was in used during the 1945. The facility was designed for the disassembly and burning of munitions and ceased operations during the 1950's. The area consists of various concrete aprons and barricaded buildings, an earth covered storage igloo, and an office building. The area is presently used as a pistol firing range. No disposal or burial of munitions is though to have occurred in this area.
"W"	Site of the Open Burning Ground, and Former and Current Ammunition Destruction Areas. Detailed discussion regarding these areas are provided in the text (sections 2.3.1 through 2.3.3).
"Y"	Railroad yard for the MLAAP. Rail cars and engines are typically stored and dispatched from this area on an as needed basis for munitions production.
"Z"	Site of the Ammunition Test Area. Detailed discussion regarding this area is provided in the text (section 2.3.4).

Table 2-2. MLAAP RI Southern Study Area
Ordnance Summary

General Ordnance	Specific Item
20 mm	Anti-Aircraft
37 mm	M306, M63
40 mm	M383 HE, M384 HE, M385 HE, M387 Proof, M387 HE, M406 HE, M407 Practice, M433 HEDP, M576 MP, M684 HE,
60 mm	M59 HE, M50 TP, M302 WP, 60 mm Mortar
81 mm	M43 HE and TP, M56 HE, M362 HE, M374 HE, M375 WP, M571 WP, 81 mm Mortar
90 mm	T-108, T-249, M371 HE, M-71 Rework
105 mm	M1, M1 Howitzer, T131, M324, M326, M345, M392, APOS-T, M393A1 TP-T, M415 WP, M456 A1 Heat, M456TP, M467 TP-T, M490 TP-t, M494E2 APERS, M546 APERS, M724E1 DSTP-T, M728 APDS-T
106 mm	N81, M344 HEAT, M346 HEP, M2581 APERS
155 mm	M107 Howitzer
Dispenser & Bomb	CBU-1, CBU-2, CBU-3, CBU-14, CBU-24, CBU-25, CBU-46, CBU-52 B/B, CBU-58 A/B, CBU-58 D-4/8, CBU-63, CBU-71 A/B, CBU-75 A/B, Bomb BLU 6 B/B HE LLD, ADU-253, ADU-272
Demolition Kits	M58, M68, M125, M157, M173, MK-15, MK-18, MK-22
Grenades	M33, MK67
Rockets	2.35 Inch, 3.5 Inch, 4.5 Inch, 5.0 Inch
8" Howitzer	
Projectile M726 Rework	
Lance WHD M251	
Shape Charge	
Cluster Bombs	
Ordnance Components	**Specific Item**
Fuzes	M483, M51, M52, M55, M62, M82, M91, M91A2 BD, M404, M519, M524A6, M525 PD, M526, M527, M557 PD, M564 PD, M572 PD, XM716, XM717, M564 MTSQ
Primers	M32, M34, M71A2
Charging Propellent	M1
XM299 Ignition Cartridge	
Lead Cup Assay F/M739 Fuze	
M1 Delay Plunger	
M2 Delay Plunger	
Initiator Burster	M1, M2
Boosters	M21, M24, M125A1

operation by installing large metal flash pans mounted on concrete pads. An active open trench (one of three trenches in Disposal Site "F") in the OBG was excavated to comply with RCRA regulations. The excavated material filled approximately 2,200 55-gallon drums of waste and contaminated soil that was manifested for off site disposal by Chemical Waste Management, Inc. The trench was backfilled following excavation of wastes and contaminated soils.

Current operations at the OBG include the following: burning of propellants/explosives and small tracers in metal flash pans mounted on concrete pads; burning of explosives-contaminated solvents/rags in metal flash pans mounted on concrete pads; percussion firing of waste primers on a modified rotary press; burning of small primers and delay elements in a propane fired oven at approximately 1,000°F; and burning and flashing of explosives-contaminated material not considered hazardous waste on burning pads. Treatment of sanitary wastes generated by operational personnel consists of a septic system consisting of a septic tank and leaching field. The septic system is not located in any known explosive related disposal area within the OBG>

2.2.2 Former Ammunition Destruction Area

The former ADA is located in Area "W" and was in operations from 1942 until 1947 when the site was abandoned. The former ADA is approximately 8 acres with operations similar to the OBG, with the additions of ordnance destruction and disposal of "problem" ordnance that were buried without detonation. Munitions returning from overseas following World War II were detonated at the MLAAP; however, munitions that could not be disassembled for safe detonation are thought to be disposed in this area. Discussions with Plant personnel have indicated that disposal may have occurred in the lower portions (gullies) of the site where trenches may have been excavated. Munitions consisting of fuzes, mortar rounds, and rocket heads may have been disposed in the area. In 1984, MLAAP personnel cleared the former ADA by hand, regraded the topography using a bulldozer to improve drainage, and seeded the area to control erosion. During these activities, ordnance items or components containing white phosphorous self-ignited when exposed to the atmosphere. These ordnance items were removed from the site during the regrading operation.

2.3 Previous Investigations and Remedial Investigation Results

A number of investigations have been performed at the MLAAP both prior to and following placement of the Plant on the NPL. Studies relating to the MLAAP Southern Study Area OBG and former ADA are summarized and presented below:

2.3.1 Report on Waste Disposal Practices, USEPA, February 1972. This study identified all methods of disposal of solid and hazardous waste at the MLAAP and recommended improvements to management practices.

2.3.2 Water Quality Biological Study Number 24-027-74/75, U.S. Army Environmental Hygiene Agency (AEHA), November 1972. This study examined the effects of waste waters on the water quality of surface streams at the MLAAP. The report identified explosive concentrations (RDX and 246TNT) that could be detrimental to aquatic life.

2.3.3 Initial Installation Assessment of MLAAP, USATHAMA, March 1978. This study consisted of an extensive record search of operations at the MLAAP with regard to the disposal and potential migration of hazardous wastes from the Plant. The study concluded that the ammunition demolition areas, wastewater lagoons, open burning grounds, and drainage ditches were contaminated with explosive wastes and that there was a potential for off site migration of hazardous chemicals.

2.3.4 MLAAP Contamination Survey: Phase II, USATHAMA, January 1982. A contamination survey was performed at MLAAP consisting of the installation of thirty-three shallow groundwater monitoring wells (Wells MI001 through MI033) during 1979 to quantify groundwater flow and to provide groundwater quality data. Groundwater, surface water, and sediment samples from ditches were collected from suspected contaminated areas. Results of the survey indicated the presence of explosives, heavy metals, and anions considered probable environmental contaminants resulting from Plant operations. Groundwater was contaminated and was found to be migrating toward the MLAAP northern boundary.

2.3.5 MLAAP Geohydrologic Consultation, USAEHA, 1982. This effort consisted of the installation of seven groundwater monitoring wells (Wells 001 through 007) around the perimeter of Area "W" in order to address RCRA groundwater monitoring requirements. Results of the effort indicated that low levels of explosive compounds were present in groundwater within the Area "W" vicinity.

2.3.6 MLAAP Environmental Survey: Phase II, USATHAMA, September 1983. A contamination survey was performed at MLAAP consisting of the installation of 23 groundwater monitoring wells (Wells MI034 through MI056) installed in the upper, middle, and lower portions of the groundwater aquifer underlaying the Plant to determine the extent of contamination originating from the "O" Line Ponds area. Explosives contamination was found in the upper, middle, and lower portions of the aquifer with the upper aquifer contaminated immediately adjacent to the settling ponds, and middle and lower portions of the aquifer contaminated down gradient of groundwater flow (north-northwesterly direction from the "O" Line area). Other explosives contamination was found in groundwater in the B-Line area, the open burning grounds, and the ADAs. Heavy metals were found in the OBG and ADAs consisting of lead, chromium, and cadmium. No continuous plume was identified. Only one well exceeded drinking water standards for heavy metals in the OBG and ADAs.

2.3.7 RCRA Facility Assessment Report, USEPA, August 1986. This report identified Solid Waste Management Units (SWMUs), identified available information pertaining to each SWMU, and assessed the likelihood of releases of hazardous wastes or constituents from each unit. The report concluded that sound waste management practices were in effect and that the potential for releases of hazardous constituents was primarily from closed areas and past operations.

2.3.8 Investigation and Engineering Analysis for Remedial Actions, Milan Army Ammunition Plant Open Burning Ground, U.S. Army Corps of Engineers (USACOE), Huntsville Division, January 1988. This investigation consisted of the identification of 24 disposal areas (Disposal Areas "A" through "Z") located within Area "W" (OBG, and the current and former ADAs) and the excavation of 58 sample pits and exploratory ditches. Soil samples were collected from the

excavations and analyzed for explosives and heavy metals. Results of the investigation indicated that three burial trench areas and six other areas found in the OBG were potential sources of groundwater contamination. The burial trenches were estimated to represent over 50% of the contamination present in the study area. Analytical data also indicated that surface burning/flashing areas were typified by generally widespread contamination which could not be attributed to discrete sources. This may be attributed to the surface earthmoving operations associated with the transport of wastes within the area (i.e. disposal of residual ash after burning/flashing into disposal trenches).

2.3.9 Milan Army Ammunition Plant, Remedial Investigation Report, USATHAMA, December 1991. A RI was conducted consisting of the installation of 26 groundwater monitoring wells (Wells MI057 through MI082), sampling and analyses, field geotechnical activities, and data evaluation to determine the magnitude and extent of contamination from source areas identified at the MLAAP, define geohydrologic parameters, and assess the risk to human health and environment. Results of the RI indicated that the major sources of groundwater contamination consist of the drainage ditches associated with various production lines, the "O" Line Ponds, the OBG and ADAs, sumps and wastewater pits at several load lines, the closed sanitary landfill, and the former borrow pit. Sources that did not require further investigation include the Closed Burning Grounds, the Sanitary Landfill, and the Salvage Yard. The activities related to the Southern Study Area includes the investigations performed at the OBG and ADAs. The Closed Burning Ground and Sanitary Landfill, both located in the southern study area do not require further investigation, as discussed in the TDEC letter to the Commander, MLAAP, dated November 24, 1992 from Ron Sells, Division of Superfund. A grid of nineteen (19) soil borings, placed at 800 foot intervals in the OBG/ADAs, were drilled at depths ranging from 15 feet to 114 feet. Results of chemical analyses from the soil borings indicated that heavy metal contamination (lead, chromium, and mercury) was present at relatively low levels, and explosive contamination was limited to three of the 19 soil borings to a depth of 15 feet. In addition, no significant organic compound contamination was detected. Soil borings located within identified disposal areas indicated contamination that correlates to past operations. These results may indicate that groundwater contamination is caused by localized disposal areas within the OBG and ADAs.

2.3.10 Milan Army Ammunition Plant, Remedial Investigation Report (Operable Unit No. 4), USAEC, August 1995. A RI was conducted for Operable Unit No. 4 to assess groundwater contamination affecting the City of Milan well field in addition to quantifying associated contaminant sources. Industrial areas involved with the munitions load-assembly-packing (LAP) operations (i.e., "A" Line, "X" Line, and possibly others) were identified as contaminant sources. Discharges from these areas (i.e., from nitrobodies-contaminated (explosives-contaminated) industrial wastewaters) prior to installation of GAC treatment systems (1981) were routed into sumps that flowed into drainage ditches reaching into Wolf Creek. Contaminants then percolated through the soil column underlying ditch and creek beds into the groundwater flow system. Recent chemical analyses indicates that the City of Milan well field has been affected by this contamination at very low levels (i.e., RDX concentrations below 0.5 μg/l). The RI consisted of the installation of 78 groundwater monitoring wells (Wells MI128, and MI134 through MI242) and 61 soil borings, sampling and analyses of various environmental media, field geotechnical activities, and data evaluation to determine the magnitude and extent

of contamination from source areas identified at the MLAAP, define geohydrologic parameters, and assess the risk to human health and environment. Activities related to the Southern Study Area (Operable Unit No. 5) include the installation of monitoring wells within the Closed Ammunition Burnout Area (MI226 through MI228, MI232, and MI233), a background well (MI229) located south of Area "I", and wells located along Route 54 (MI157 through MI162, MI168 through MI173, and MI216 and MI217. Data from these wells are incorporated in this RI.

2.4 Data Evaluation of Previous Investigations

Data evaluation pertinent to the scoping of the RI is presented in this section. An independent evaluation of the data was conducted to identify data gaps that required resolution to characterize the nature and extent of risks posed by contamination present within the site. Results of each investigation are presented to assess site conditions prior to the conduct of the RI.

2.4.1 MLAAP Contamination Survey: Phase II, USATHAMA, January 1982.

A contamination survey was conducted by Envirodyne Engineers, Inc. through the USATHAMA to quantify contamination present at the site. This survey was a follow-up to the off-plant Phase I survey conducted in 1979 (Section 2.4.5). Geohydrological data collected (wells MI001 through MI033) focused on the shallow portion of the regional aquifer. Groundwater flow contours were in error due to incorporation of incorrect survey data (elevation data), and misinterpretation of a perched water zone (well MI021) as part of the regional groundwater flow system. This misinterpretation was carried over throughout all subsequent investigations. A groundwater piezometric surface (water table) contour map is provided (Figure 2-2) using survey data, along with projected flow directions. Groundwater contours were found to be fairly consistent with results of the southern study area RI. Groundwater contamination results (applicable to the southern study area only) (Figure 2-3) detected various levels of nitrobodies; however, internal DA groundwater standards for RDX and 246TNT (35 and 45 μg/l, respectively) in effect at the time indicated that no immediate remedial actions were necessary. Also, chemical analytical data collected was suspect due to QA/QC considerations. Groundwater contamination by nitrobodies was indicated at the OBG, current ADA, and railroad yard. Heavy metals were also detected; however, the validity of this data is doubtful (results excessively high) based upon comparisons with more recent data. In addition, data management transcription errors are probable.

Data presented for other environmental media (Figures 2-4 through 2-6) are presented for informational purposes only, and should <u>not</u> be considered representative of actual field conditions at that time. Results indicated the presence of nitrobodies and selected heavy metals (CD, CR, HG and PB) at the MLAAP in all environmental matrices.

Figure 2-2. MLAAP Contamination Survey Phase II (1982) Groundwater Piezometric Surface Map

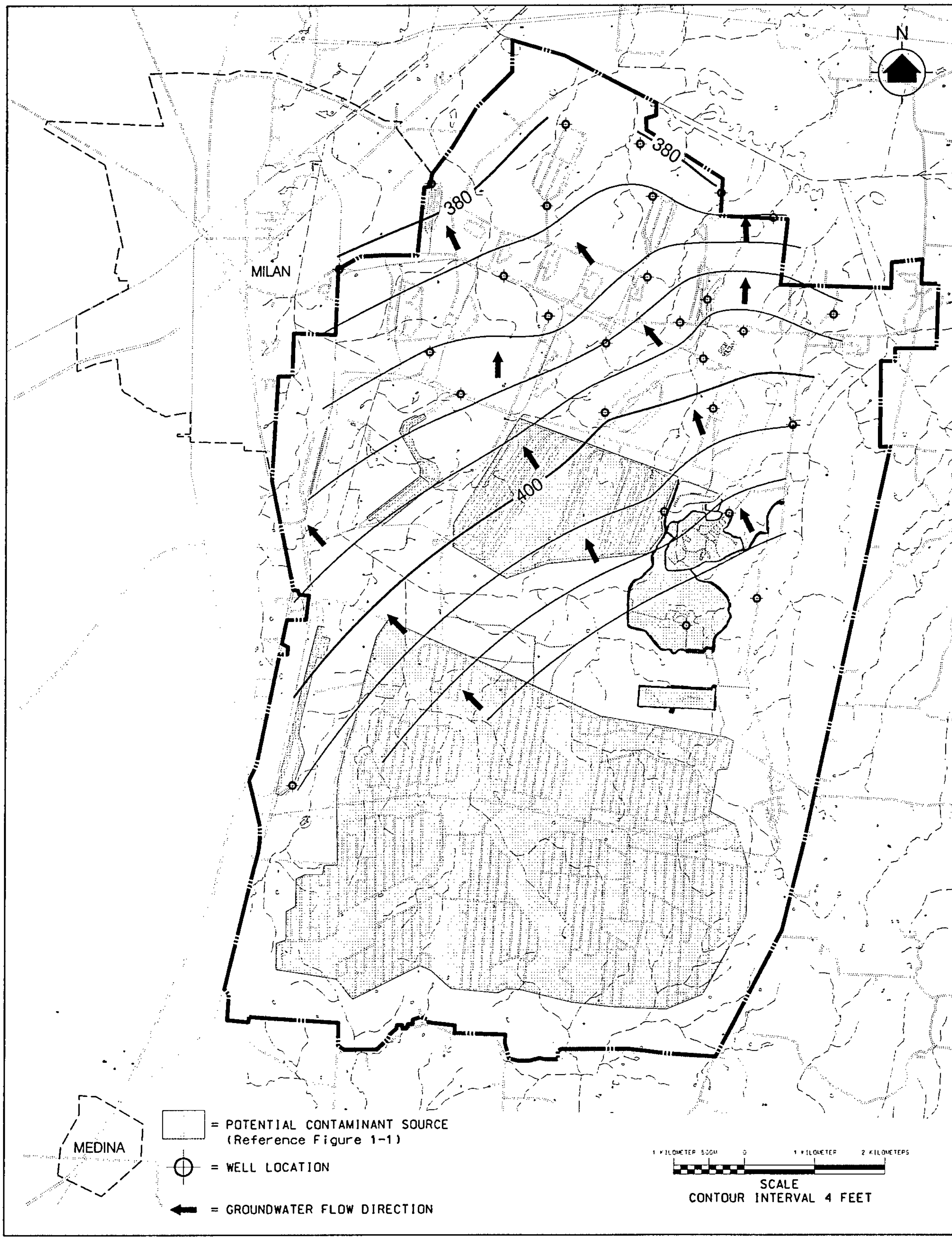


Figure 2-3. MLAAP Contamination Survey Phase II (1982) Groundwater Contamination Map

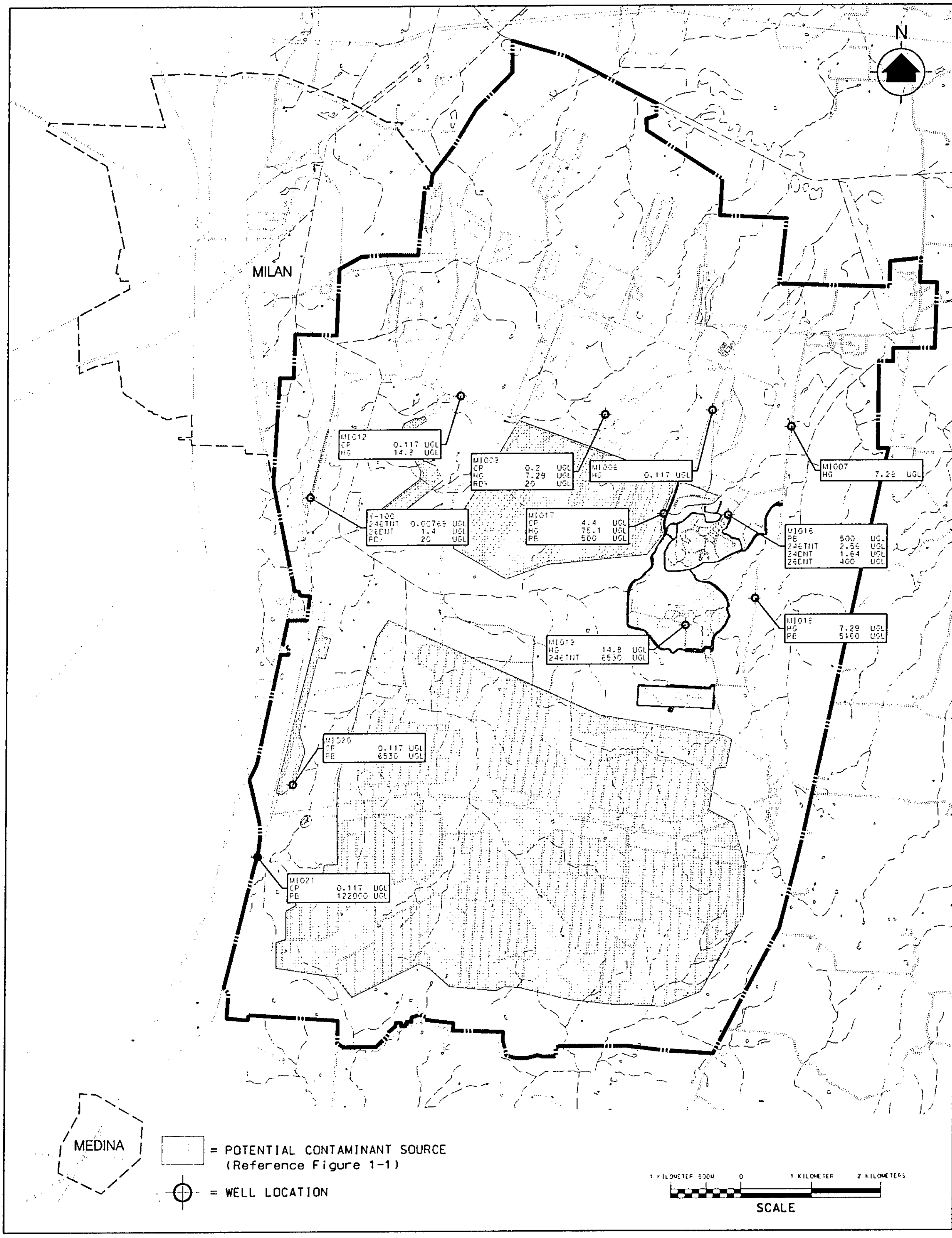


Figure 2-4. MLAAP Contamination Survey Phase II (1982) Surface Soil Contamination Map

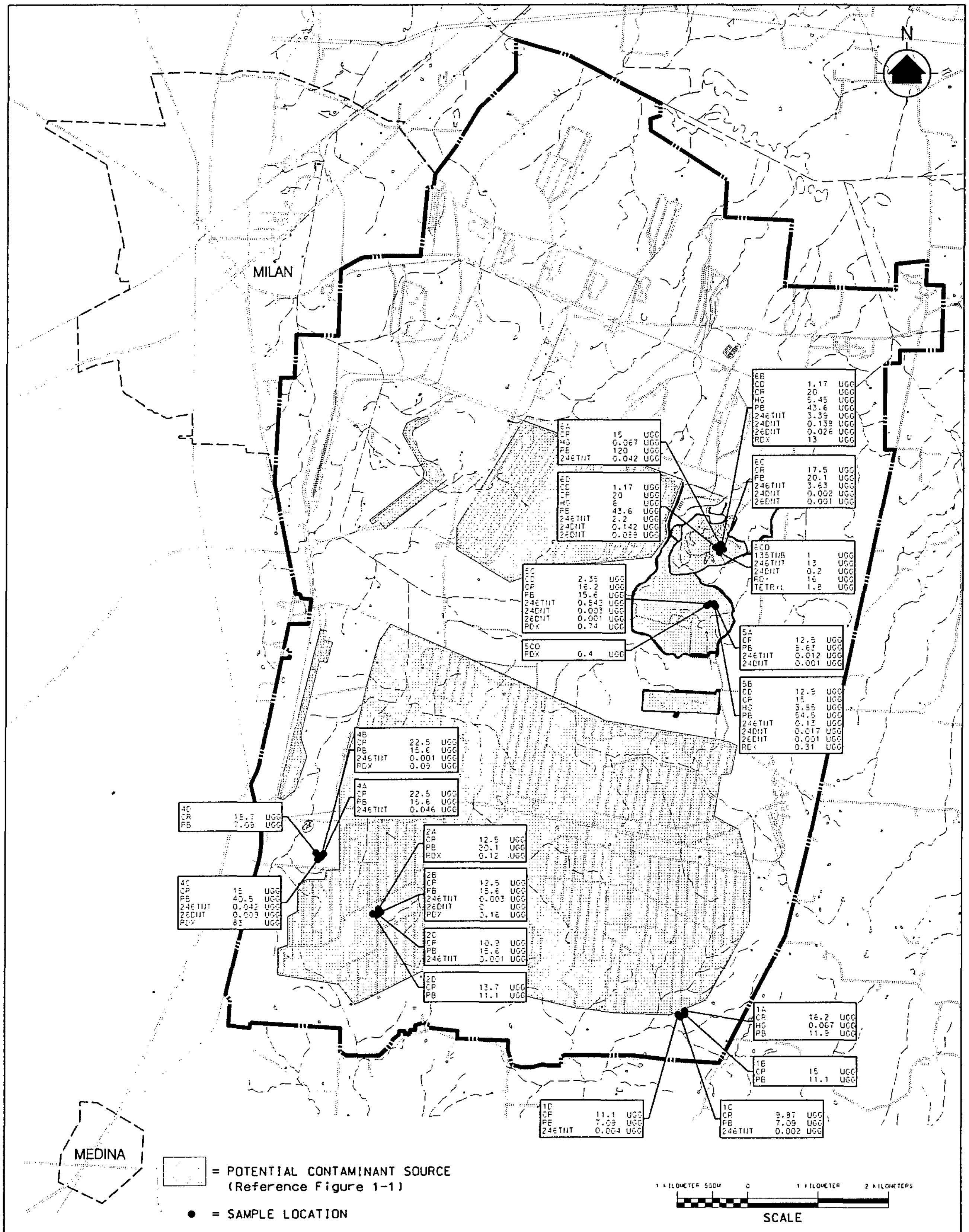


Figure 2-5. MLAAP Contamination Survey Phase II (1982) Surface Water Contamination Map

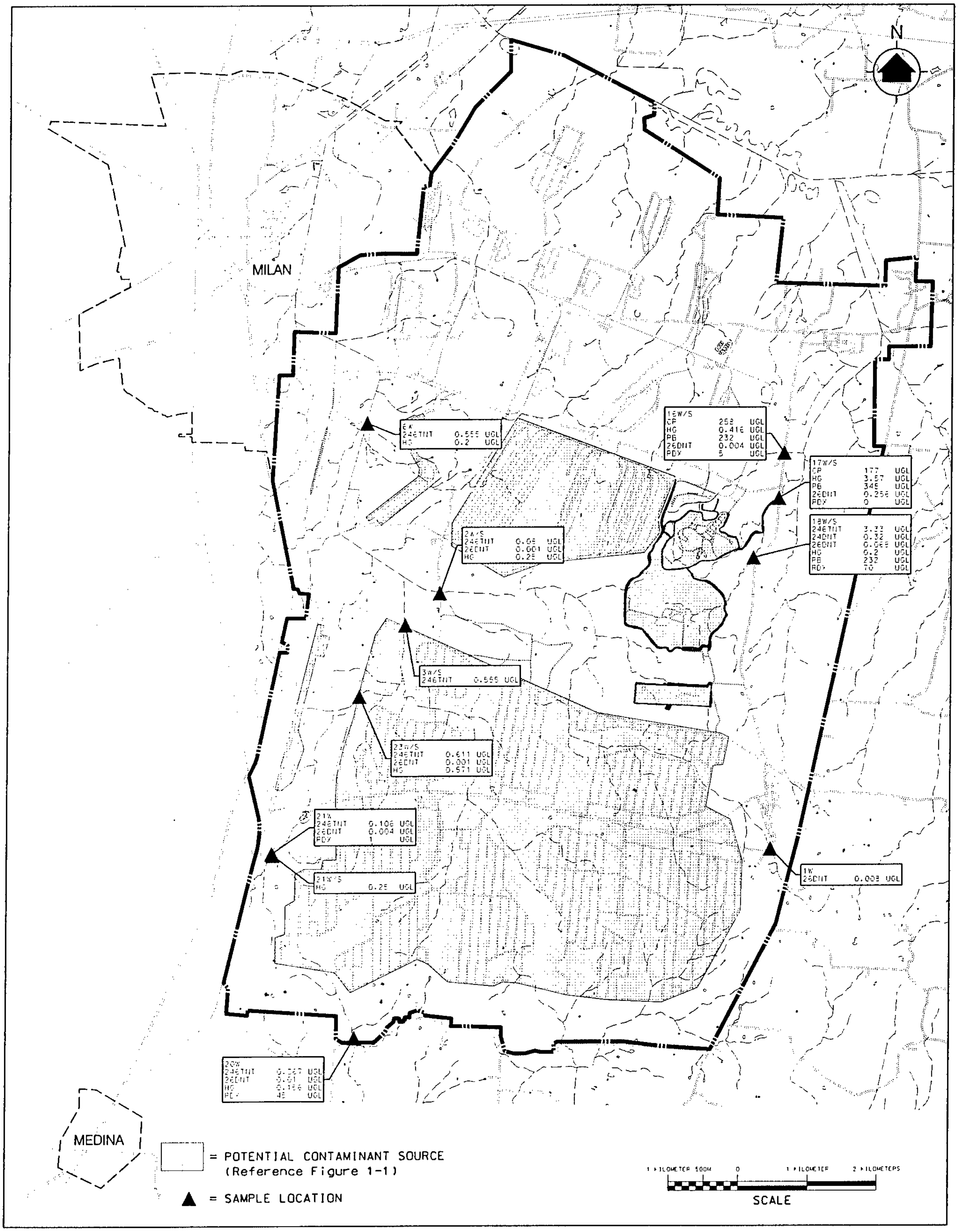
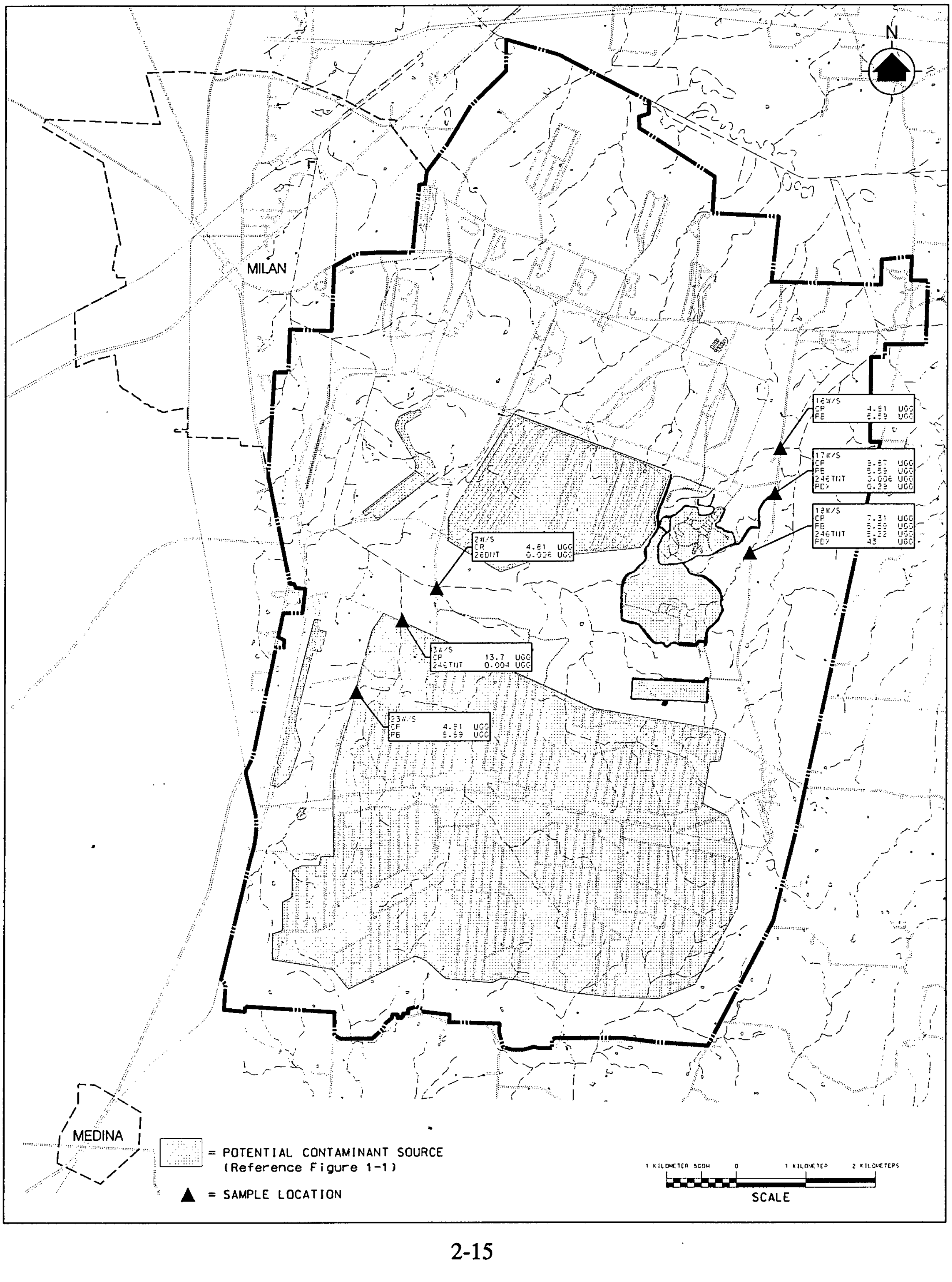


Figure 2-6. MLAAP Contamination Survey Phase II (1982) Sediment Contamination Map



2.4.2 MLAAP Geohydrologic Consultation, USAEHA, 1982.

The USAEHA installed seven groundwater monitoring wells (001 through 007) to address RCRA groundwater requirements for open burning/open detonation of ordnance related materials. These monitoring wells were installed in the middle and deep portions of the regional aquifer and assisted in better defining groundwater table contours (Figure 2-7) and contaminant levels of nitrobodies from the OBG and current ADA (no contamination was detected in the ADA) (Figure 2-8). These additional data suggested that groundwater contamination was migrating vertically and horizontally within the regional aquifer. However, the groundwater monitoring network was not sufficient to quantify contaminant plumes from these areas.

2.4.3 MLAAP Environmental Survey: Phase II, USATHAMA, September 1983.

A contamination survey was conducted by Roy F.Weston, Inc. through the USATHAMA to quantify contamination present at the site. This survey was a follow-up to the Phase II survey conducted in 1979 and focused primarily on the "O" Line settling ponds area, but did include resampling of all monitoring wells on the plant. Geohydrological data collected (wells MI034 through MI056) focused on the shallow middle and deep portions of the regional aquifer in the vicinity of the "O" Line area. Groundwater flow contours were in error due to incorporation of incorrect survey data (elevation data), and misinterpretation of a perched water zone (well MI021) as part of the regional groundwater flow system. This misinterpretation was carried over throughout all subsequent investigations. A groundwater piezometric surface (water table) contour map is provided (Figure 2-9) using survey data, along with projected flow directions. Groundwater contours were found to be fairly consistent with results of the southern study area RI. Groundwater contamination results (applicable to the southern study area only) (Figure 2-10) detected low levels of nitrobodies; however, internal DA groundwater standards for RDX and 246TNT (35 and 45 μg/l, respectively) in effect at the time indicated that no immediate remedial actions were necessary. Heavy metals were also detected (CD, CR, HG and PB) throughout the MLAAP. CR levels in MI021 may be suspect based upon comparison to more recent data. This monitoring well is screened within a perched water zone. Results from the contamination survey provided the technical data to justify a remedial action for the "O" Line settling ponds were a multi-layer cover system was installed in accordance with RCRA requirement to prevent additional leaching of contaminants from the ponds into the regional groundwater flow system. High levels of nitrobodies were detected in groundwater in the "O" Line and down gradient area.

2.4.4 Investigation and Engineering Analysis for Remedial Actions, Milan Army Ammunition Plant Open Burning Ground, USACOE, Huntsville Division, January 1988.

A contamination survey and engineering analysis for remedial action was conducted by Post, Buckley, Schuh, and Jernigan, Inc. through the USACOE, Huntsville Division. This effort incorporated a detailed evaluation of past operations through systematic evaluation of historical aerial imagery, interviews with operational personnel, and surface geophysical methods to located individual disposal sites within the OBG. Surface geophysical methods were not found to be conclusive; however, historical imagery and personnel interviews provided sufficient data to locate individual disposal sites (Table 2-3 and Figure 2-11). Twenty-five disposal areas

Figure 2-7. MLAAP Geohydrologic Consultation (1982) Groundwater Piezometric Surface Map

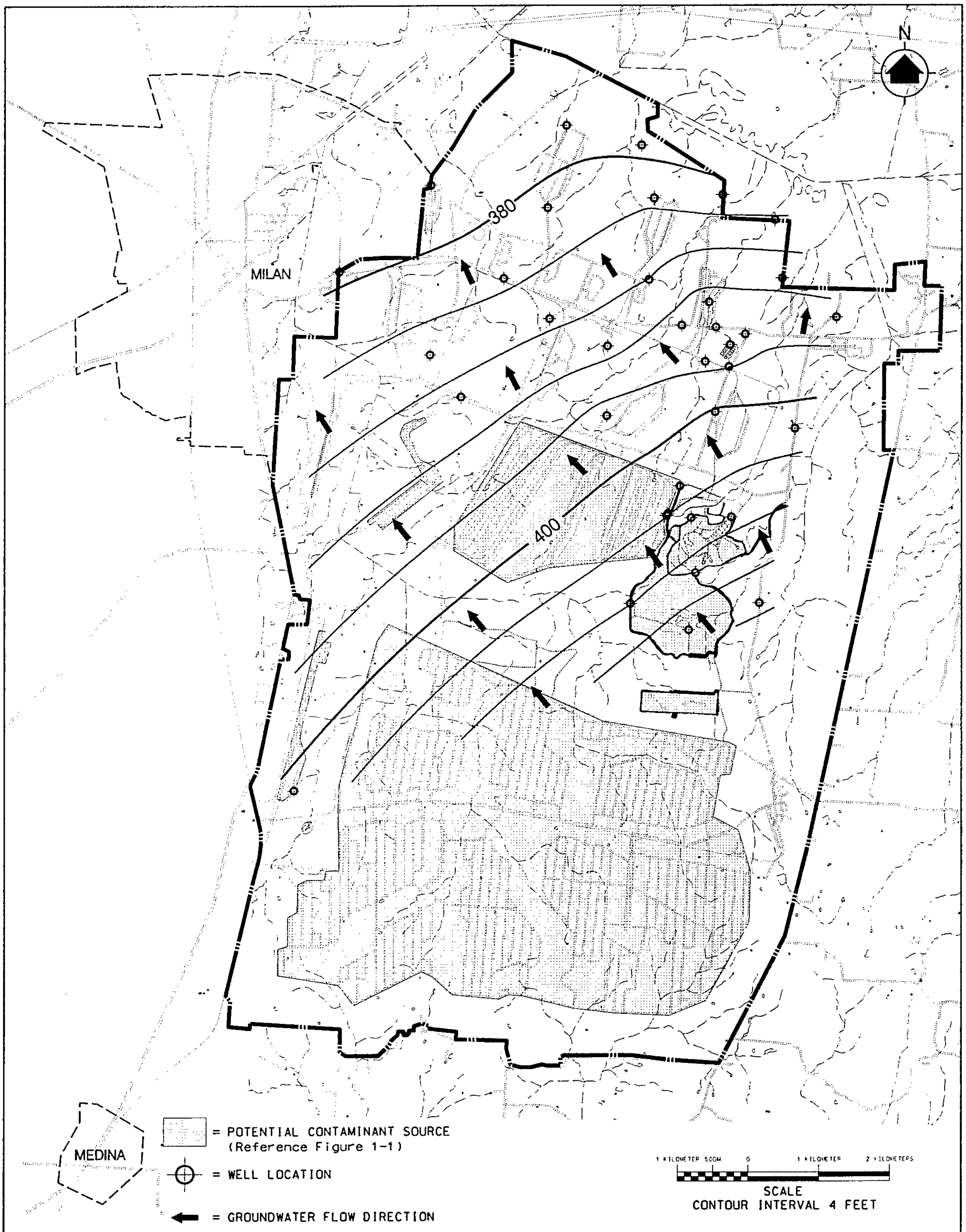
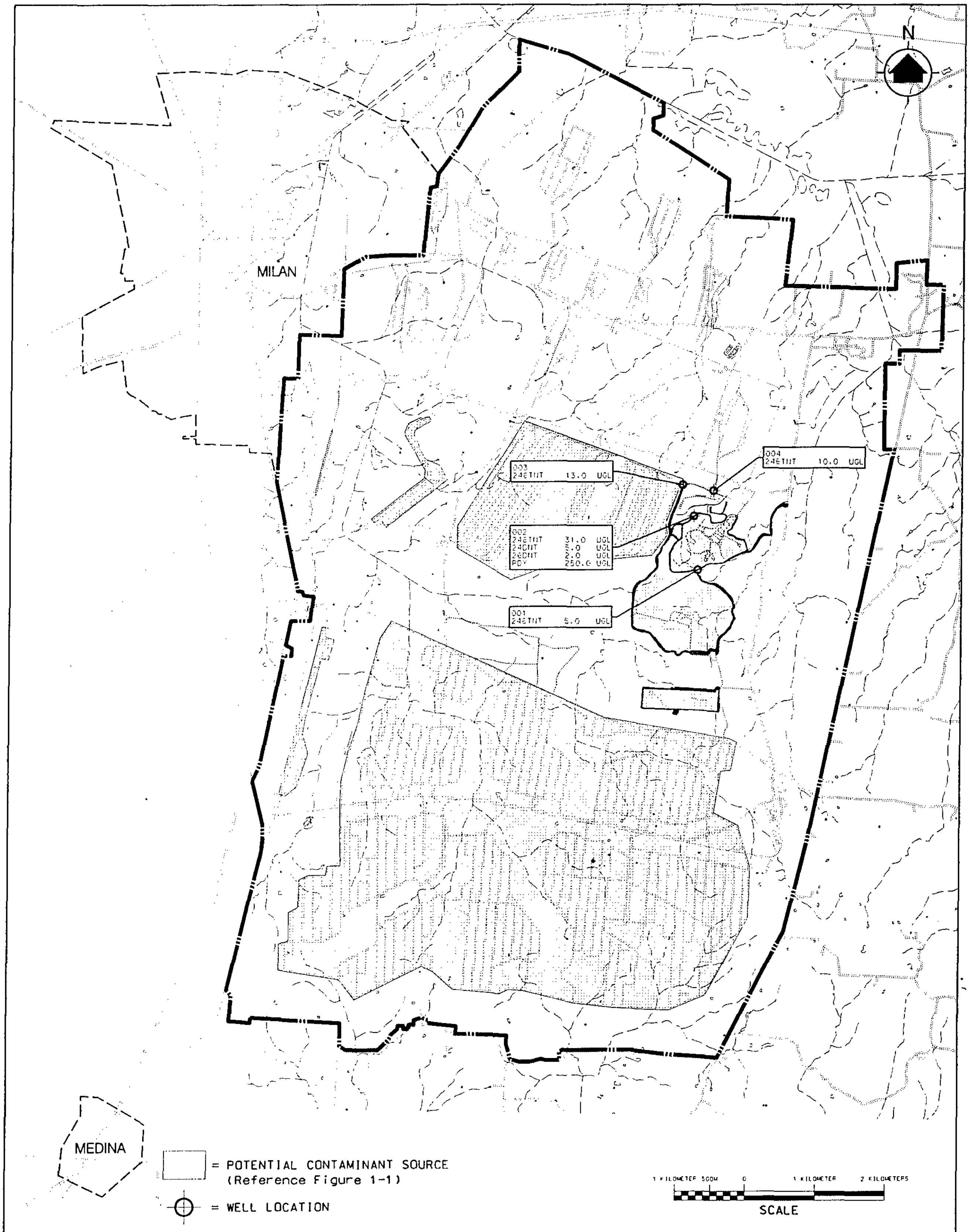


Figure 2-8. MLAAP Geohydrologic Consultation (1982)
Groundwater Contamination Map



2-18

Figure 2-9. MLAAP Environmental Survey: Phase II (1983) Groundwater Piezometric Surface Map

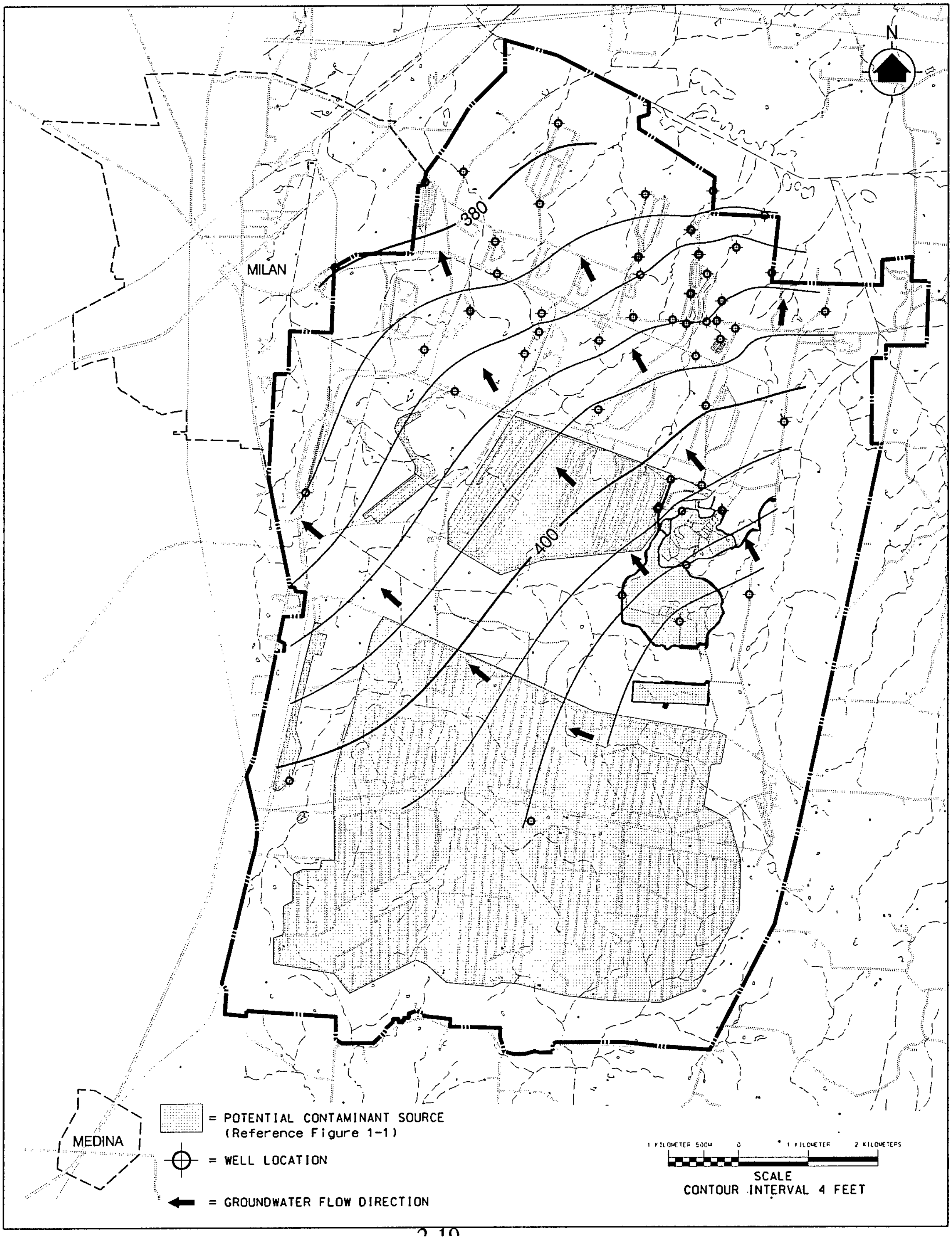


Figure 2-10. MLAAP Environmental Survey: Phase II (1983) Groundwater Contamination Map

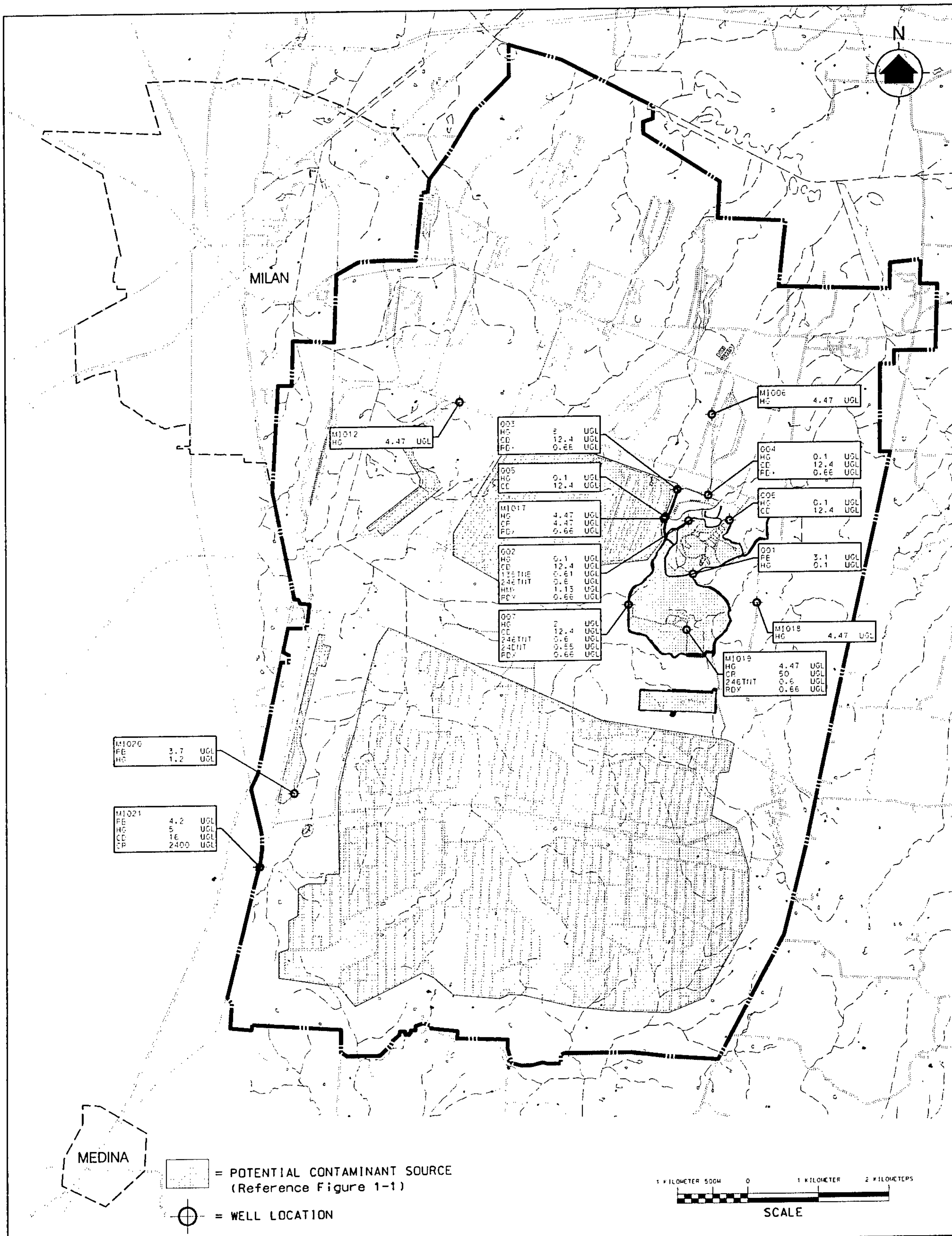


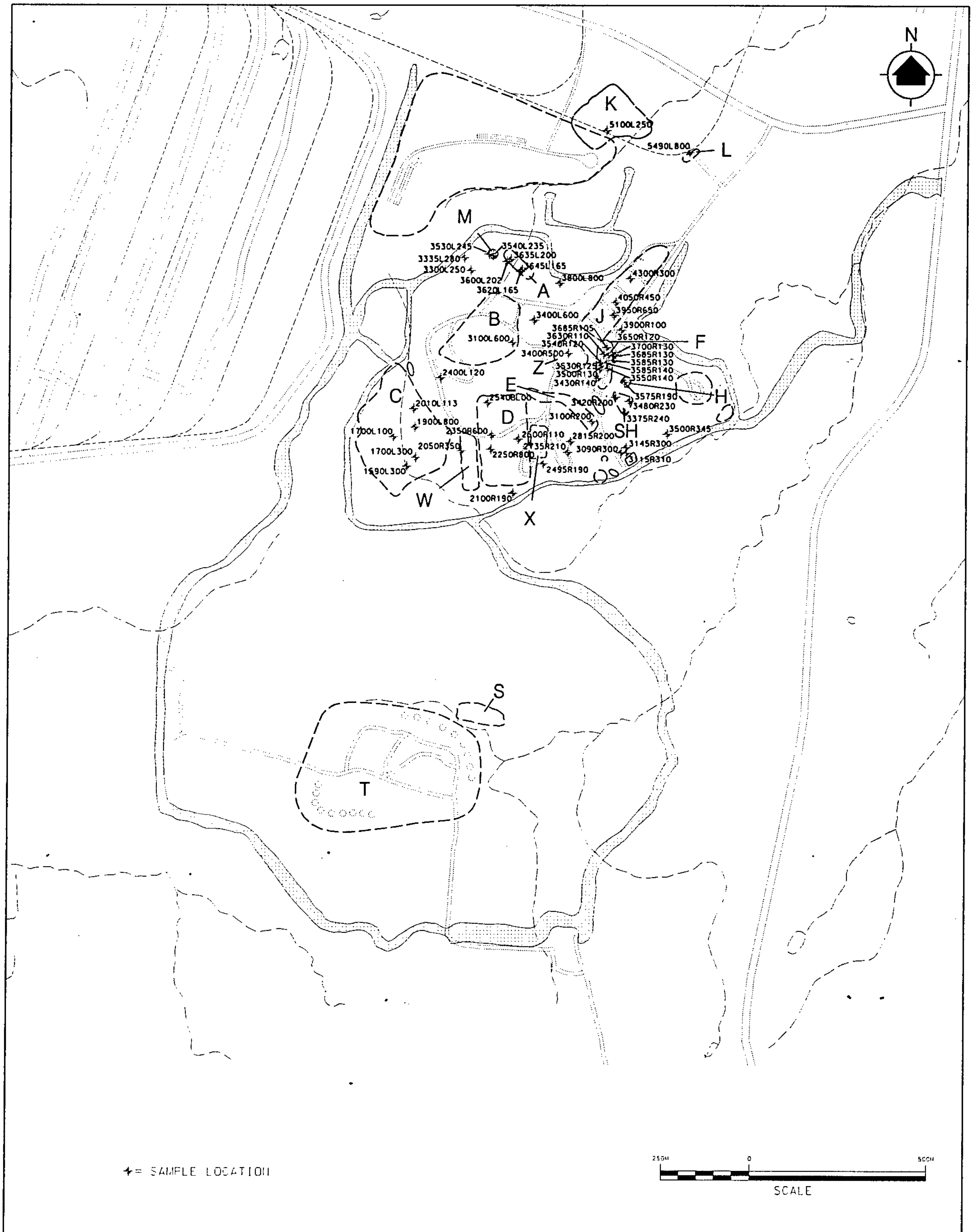
Table 2-3. MLAAP RI Southern Study Area
Area "W" (OBG, and Current and Former ADAs) Waste Disposal Sites.

Disposal Site	Description
"A"	One or two 250-foot long, 15-foot wide, and 10-foot deep disposal trench(es). The trench(es) runs east-west with the easternmost end being located approximately 400 feet west-northwest of the W-2 office building. At either end of the trench(es) is a spoil pile from excavation of the trench. This trench was primarily used for disposal of explosive contaminated shells and of ash resulting from the open burning of bulk explosives. Several potentially live munitions were found at the surface near this area. Aerial photographs indicate that there may have been two trenches located in this area as opposed to the single trench identified through interviews. These trenches appear to have been active from the mid-1960's to the mid-1970's.
"B"	Two areas used for the surface burning of bulk explosives/propellant and shells from 1942 until 1983. The larger open surface burning area (approximately 500 feet by 750 feet) is located on the south side of the road encompassing the area where the burning pans are currently located. The smaller area (approximately 250 feet by 175 feet) is located on the north side of the road encompassing the area where the primer firing and flashing area is currently located. Both of these areas are relatively flat and would be expected to have general and widespread soil contamination by explosive chemical components.
"C"	This area is the old Ammunition Destruction Area (ADA). The old ADA encompasses an area of approximately 500 feet by 700 feet and was used from 1942 to 1947. In 1984 the area was leveled by bulldozer, tilled, and sodded to enhance drainage in the area. During this operation, several shells of white phosphorous were exposed and burned out. White phosphorous was burned primarily on the hill located to the east of the drainage ditch that runs through the old ADA.
"D"	A large area (approximately 750 feet by 500 feet) used for bulk explosive/propellant burning on the ground's surface. After the burns were completed, the burn area would be raked and scraped with the ashes being disposed of in the trench indicated as "A" and any metal being sent to salvage. Burial of inert and possibly live ordnance occurred in this area during its use from the early 1950's to the mid-1970's.
"E"	An area used for the disposal of ash and 20/40 mm projectiles from which the tracer had been burned out. This area was located primarily in the first 1,000 feet of the drainage ditch that runs from just south of Building W-10 toward the east then toward the southeast. The projectiles were inert when received by OBG personnel and only needed to have the tracer burned out. The ash resulted from the surface burning of bulk explosives and propellant.
"F"	An area consisting of three parallel disposal trenches that were utilized from the mid 1970's until 1983 when the easternmost trench was removed and backfilled. These trenches ran north-south within each trench approximately 300 feet long, 15 feet wide and 15 feet deep.
"G"	An area consisting of 4-6 trenches used for the disposal of bulk liquid paints, and garbage without burning from the late 1950's to the mid 1970's. The trenches run in general northeast-southwest pattern and are located about 600 feet east of the explosive contaminated waste burning area. Each trench is approximately 60 feet long, 20 feet wide and 5 feet deep. Paints were poured from 55-gallon drums into these trenches.
"H"	An area where three pallets of live 40 mm ordnance were stacked and set on fire with wood behind a soil berm or barricade. This barricade can still be utilized to locate the area. There is evidence that potentially live 40 mm ordnance was inadvertently buried at the site by the ensuing explosion and potentially live 40 mm ordnance and inert 40 mm projectiles were found in and around the barricaded area during the site inspection.
"SH"	Area located 150 feet south of Disposal Area "H" used as a surface burning/flashing area for laboratory wastes and ordnance items.
"J"	A 200 foot by 750 foot area located in the relatively flat area across (east) the road from the office that was used for the open surface burning of bulk explosives/propellants and for the flashing of metals during the period from the mid-1940's to the late 1950's. This area runs northeast to southwest from the front gate (Building W-1A) to near the Weather Balloon Shelter.
"K"	A low lying area of about 150 feet by 300 feet where explosive contaminated paper was burned in pits from the early 1940's until the late 1960's. The majority of the burning and pits were located between Track 60 and Route No. 54 and some burning was done on the south side of Track 60 and west side of the drainage ditch. Some mounds of ash that were removed from the burning pits were seen during the site inspection of this area.
"L"	Location of a diesel-fired incinerator that was used to burn the tracer from 40 mm projectiles and flash other contaminated metals. The incinerator was located on a concrete pad and the burned projectiles were loaded from the incinerator into wheelbarrows and onto flatcars on Track 60. This practice began in the mid-1940's and was discontinued in the early 1960's and the concrete pad has since been demolished.
"M"	A natural depression where mud/sludge from the "O" Line ponds was dumped. The depression is located at the west end of the trench designated as "A". In fact, the spoils at the west end of "A" appear to be holding water in the area where the sludge was disposed. The disposal area appears to be in about a 40 foot diameter circle in the lowest point of the depression. Dates and amounts of disposal are unknown.
"N"	A small area where spent activated carbon from the pink-water treatment plant had been dumped and subsequently removed and disposed. The approximate dimensions of the area are 10 feet by 20 feet and the area is located on the east side of the old ADA road, about 150 feet north of the former ADA boundary. The carbon was excavated from the area and disposed in 1983,
"P"	Location of burial site of an explosive pouring machine (mechanical cow) that had been partially decontaminated at the OBG. The machine is buried at a depth of approximately five feet.

Table 2-3. MLAAP RI Southern Study Area
Area "W" (OBG, and Current and Former ADAs) Waste Disposal Sites.

Disposal Site	Description
"Q"	An area that was used to dispose of approximately 40,000 to 50,000 pounds of Ammonium Nitrate. The chemical was in 100# double-layer paper sacks and was buried in two pits located approximately 300 feet east/southeast of current explosive-contaminated waste burning area, almost to the fire break. The larger pit ran in a northwest-southeast direction, and its approximate dimensions were 75 feet long by 13 feet wide by 15 feet deep. The smaller pit was adjacent to the larger pit to the southwest. This disposal took place around 1955.
"R"	This 125-foot square area was designated as the "Old Hopper Area" were waste munitions casings, etc. were flashed in hoppers and on tables from the mid-1940's to the mid-1970's. This area is currently the location of the uncontaminated waste burning area. The ashes from this operation were disposed in a "trench" and the inert 40 mm casings and projectiles were sent to salvage.
"S"	A 200 foot by 500 foot area used for destruction of white phosphorous containing ordnance from the mid-1940's to the early 1950's. Remnants of these ordnance have been recently discovered.
"T"	Area known as part of the current ADA which has been in use since the former ADA (Area "C") was abandoned in 1947. The area on the map shown as the "firing area" is now inactive and has been graded and sodded as was Area "C". The remaining sections of the new ADA are still actively used for ammunition destruction. The entire area has approximately dimensions of 750 feet by 1,250 feet.
"U"	A small area used for the flashing of potentially contaminated materials, located to the east of the "Old Hopper Area" (Area "R"). Dimensions and dates of operation for this area are unknown.
"V"	A small area used for flashing fuel tanks, light poles, etc. The dimensions and dates of operation for this area are unknown.
"W"	A 100 foot by 300 foot area that appears to have been utilized for ammunition destruction during the late 1960's and early 1970's. This deduction was made based strictly on the aerial photographs from that period.
"X"	A 200 foot square area used for the flashing of explosive contaminated materials from the mid-1950's to the present.
"Y"	A small metal components flashing area about which the dimensions and dates of operation are unknown.
"Z"	The area in which three burning pens were located from the early 1960's to the mid-1970's. Each pen was located on a 30 foot by 60 foot cleared area.

Figure 2-11. Investigation & Engineering Analysis for Remedial Actions MLAAP OBG (1988) Contamination Source Areas Map



(Disposal Areas "A" through "Z") were identified within the OBG and ADAs where various ordnance disposal related activities occurred. Due to potential UXO hazards present in the OBG, a robotics controlled backhoe was used to trench into identified disposal areas for collection of soil samples to determine nitrobodies and heavy metals concentrations. Soil samples were primarily collected within disturbed soil zones (less than 20 feet in depth) where disposal activities were evident. Residual levels of nitrobodies (RDX and 246TNT) were detected up to levels exceeding 100 μg/g in soil. Disposal Area "F" was found to contain the highest levels of nitrobodies within the OBG. Heavy metals were also detected with PB occurring at highest concentrations throughout the OBG followed by CR and CD, respectively. Highest concentrations of PB were detected in Disposal Areas "A", "D", "M", "G" and northwest of "B"; highest concentrations of CR in Disposal Areas "A", "D", "G" "SH", and northwest of "B": and highest concentrations of CD in Disposal Areas "A", "G" "SH", and "B". Results of the survey formed the basis for further soil investigation in the southern study area RI (soil boring depth and locations). Other nitrobodies (135TNB, HMX and TETRYL) were also quantified in the investigation, but were not detected at the same frequency and levels as RDX and 246TNT.

2.4.5 MLAAP, Remedial Investigation Report, USATHAMA, December 1991.

A remedial investigation for the MLAAP site was conducted by ICF Kaiser Engineers, Inc. for the USATHAMA to further quantify contaminant sources and related contaminant migration. Twenty-six monitoring wells (MI057 through MI082) were installed to augment existing geohydrological data. Monitoring well installation focused on the northern portion of the site with the exception of well MI073 installed in the closed ABA. Soil borings were also installed within the OBG, former and current ADAs, ABA and sanitary landfill to quantify soil contamination with depth.

Groundwater flow patterns were misinterpreted due to incorporation of incorrect survey data (elevation data), and misinterpretation of a perched water zone (well MI021) as part of the regional groundwater flow system. A groundwater piezometric surface (water table) contour map is provided (Figure 2-12) using investigation data, along with projected flow directions. Groundwater contours were found to be fairly consistent with results of the southern study area RI.

Groundwater chemical analytical results (Figure 2-13) indicated the presence of PB throughout the entire MLAAP site suggesting that PB is present as a background contaminant. Low levels of nitrobodies were detected within the OBG, and former and current ADA areas. Nitrobodies were not detected in the ATA or closed ABA. One reading (24DNT) was found (well E-67) in the ASA. Heavy metals contamination (CD, CR, HG and PB) was found throughout the site for both filtered and unfiltered groundwater samples. No adequately placed monitoring well was sited at the sanitary landfill to assess potential groundwater contamination.

Soil borings installed within the OBG and ADAs (Figure 2-14) were placed in a grid pattern that, in general, did not coincide with disposal area locations, thus chemical analytical results were inconclusive in assessing contamination from these sites.

Figure 2-12. MLAAP Remedial Investigation (1991) Groundwater Piezometric Surface (Groundwater Table) Map

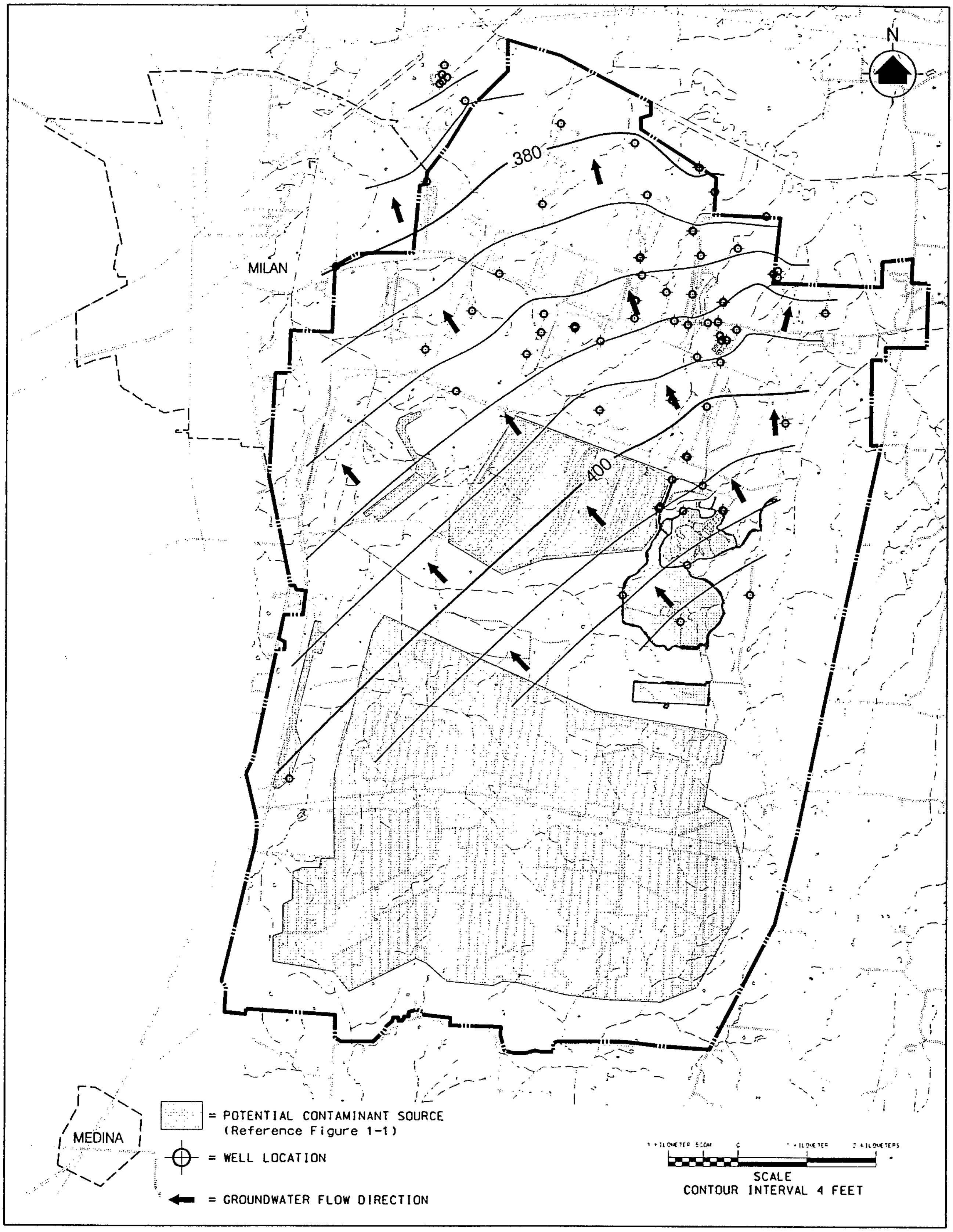


Figure 2-13. MLAAP Remedial Investigation (1991) Groundwater Contamination Map

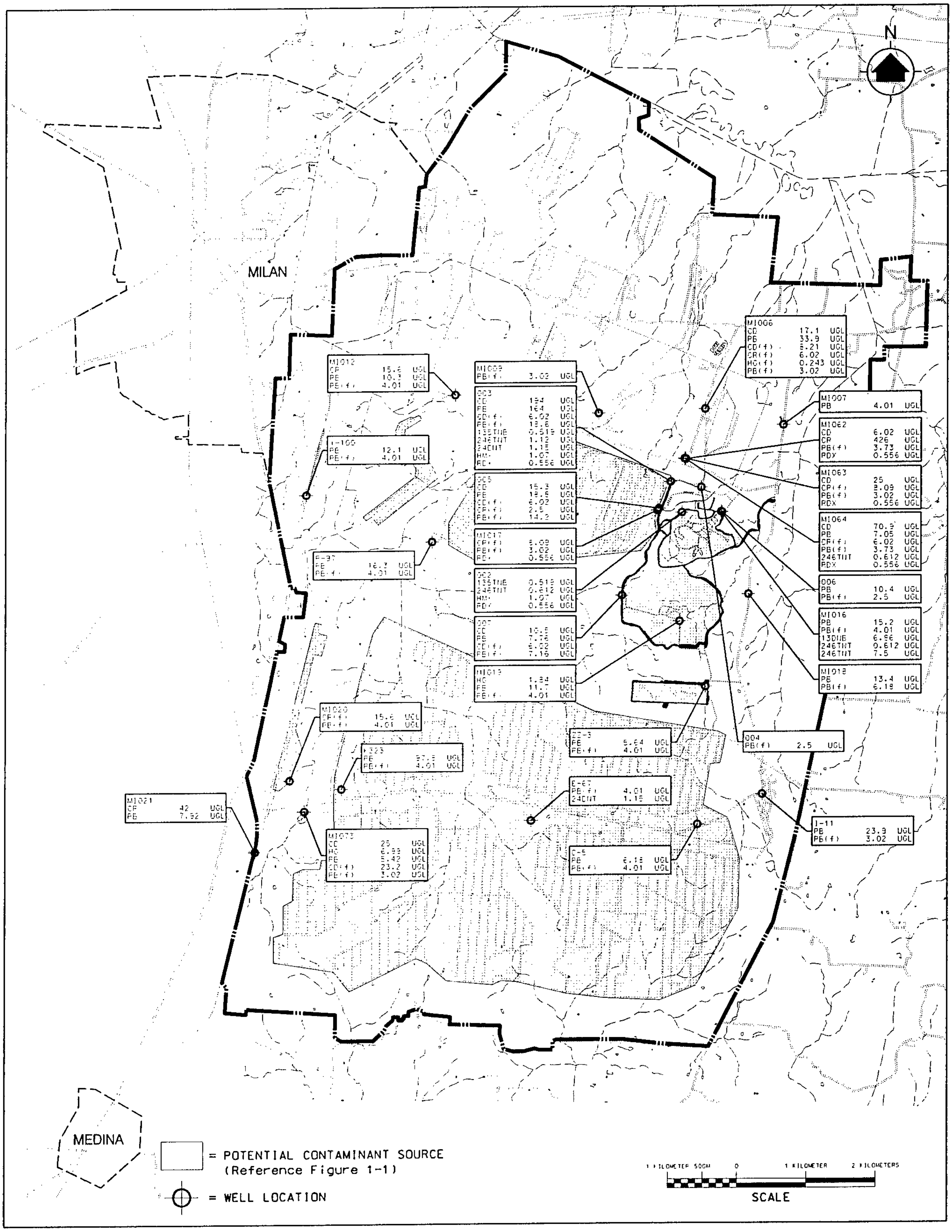
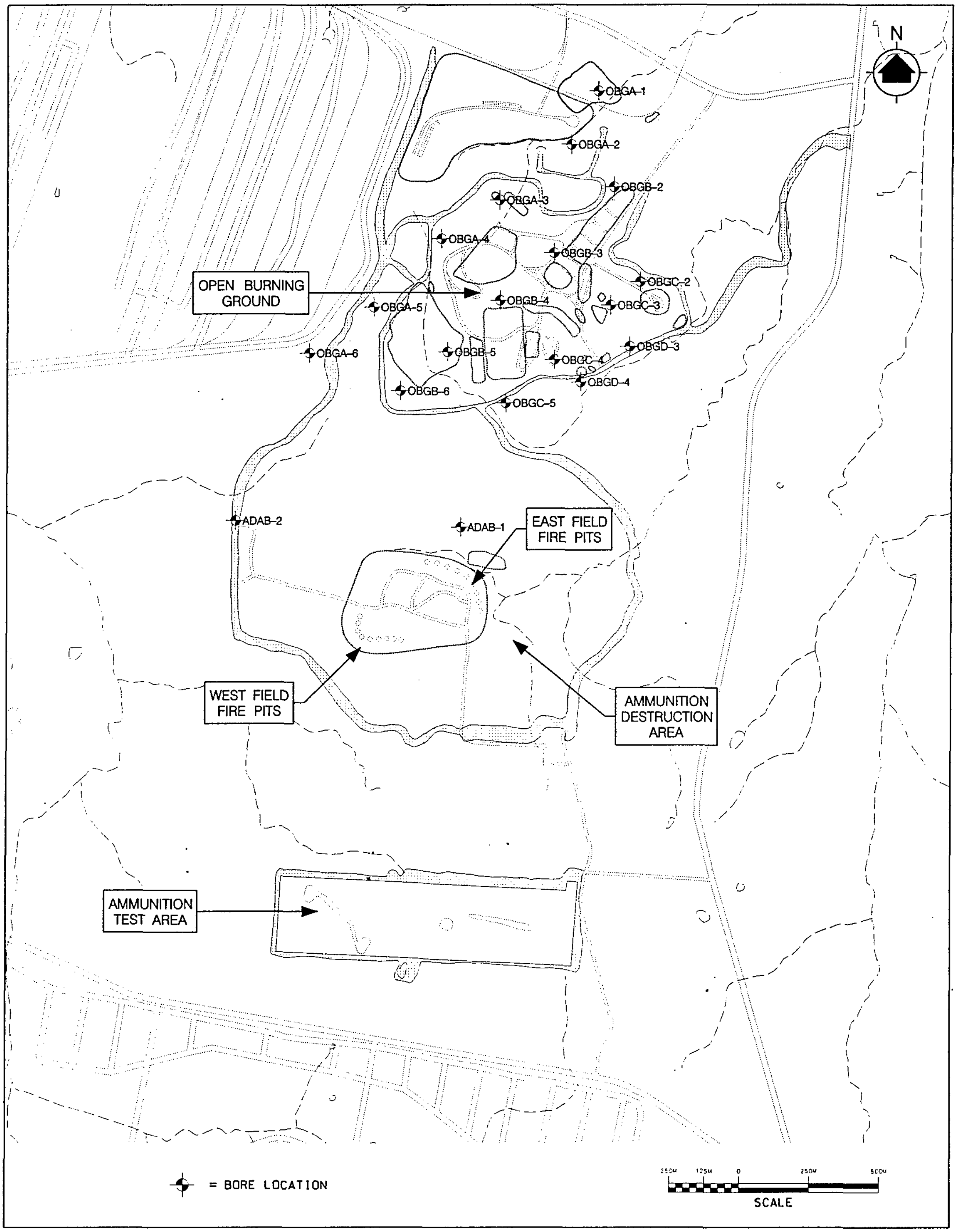


Figure 2-14. MLAAP Remedial Investigation (1991) OBG and ADAs Soil Boring Location Map



Heavy metals contamination (CR and PB) appeared to be more widespread within the soil column in contrast to nitrobodies that appeared in the upper surface zones.

Surface water chemical analytical results (Figure 2-15) indicated the presence of heavy metals (primarily CR and PB) in drainage ditches associated with the OBG and ADAs. Nitrobodies were only detected in a drainage ditch associated with the current ADA. Most of the drainage ditches within the OBG and ADAs were dry during the sampling campaign.

Sediment water chemical analytical results (Figure 2-16) indicated the presence of heavy metals (primarily CR and PB) in drainage ditches associated with the OBG and ADAs. Nitrobodies were only detected in drainage ditch sediment associated with the current ADA. Heavy metals (CR and PB) were detected in sediments located in creeks upgradient of the ASA and closed ABA.

2.4.6 Milan Army Ammunition Plant, Remedial Investigation Report (Operable Unit No. 4), USAEC, 1995.

A RI was conducted for the Northwest Study Area (Operable Unit No. 4) by Environmental Resources Management, Inc. (ERM) through the USAEC to assess groundwater contamination affecting the City of Milan well field in addition to quantifying associated contaminant sources. Fluor Daniel and ERM conducted a joint effort in June 1994 to collect monitoring well groundwater depth measurements for the entire MLAAP site in order to generate a groundwater piezometric surface map (Figure 2-17) for the regional aquifer. Groundwater chemical results (Figure 2-18) indicated levels of nitrobodies along the northern boundary of the southern study area (Route 54) that may be associated with the ASA (western portion of Route 54) and the OBG (easter portion of Route 54). Groundwater results for monitoring wells installed in the vicinity of the closed ABA indicated very low levels of nitrobodies (135TNB and 13DNB) in the perched groundwater zone (MI227). Heavy metals (CR and PB) were detected at levels consistent with background levels with upgradient groundwater (MI229) with the exceptions of wells K323 and MI172 where lead was found at 22.9 μg/l and 18.4 μg/l, respectively.

2.4.7 Milan Army Ammunition Plant, Phytoremediation Pilot Study, USAEC, 1996.

A pilot study of the effectiveness of phytoremediation was performed by ESE and ERM during 1996. Surface soil samples taken to aid in selection of a pilot study site within the OBG indicated widespread explosives contamination within and south of Disposal Area "B". Sample locations were deliberately selected from areas with visual evidence of ordnance disposal, thus results were not representative of average conditions within the area. A ground depression on the north side of Disposal Area "B" receives surface drainage and sediment from the northern half of the disposal area that results in ponding of surface water and an intermittent hydraulic head for infiltration of surface water into the soil column.

Figure 2-15. MLAAP Remedial Investigation (1991) Surface Water Contamination Map

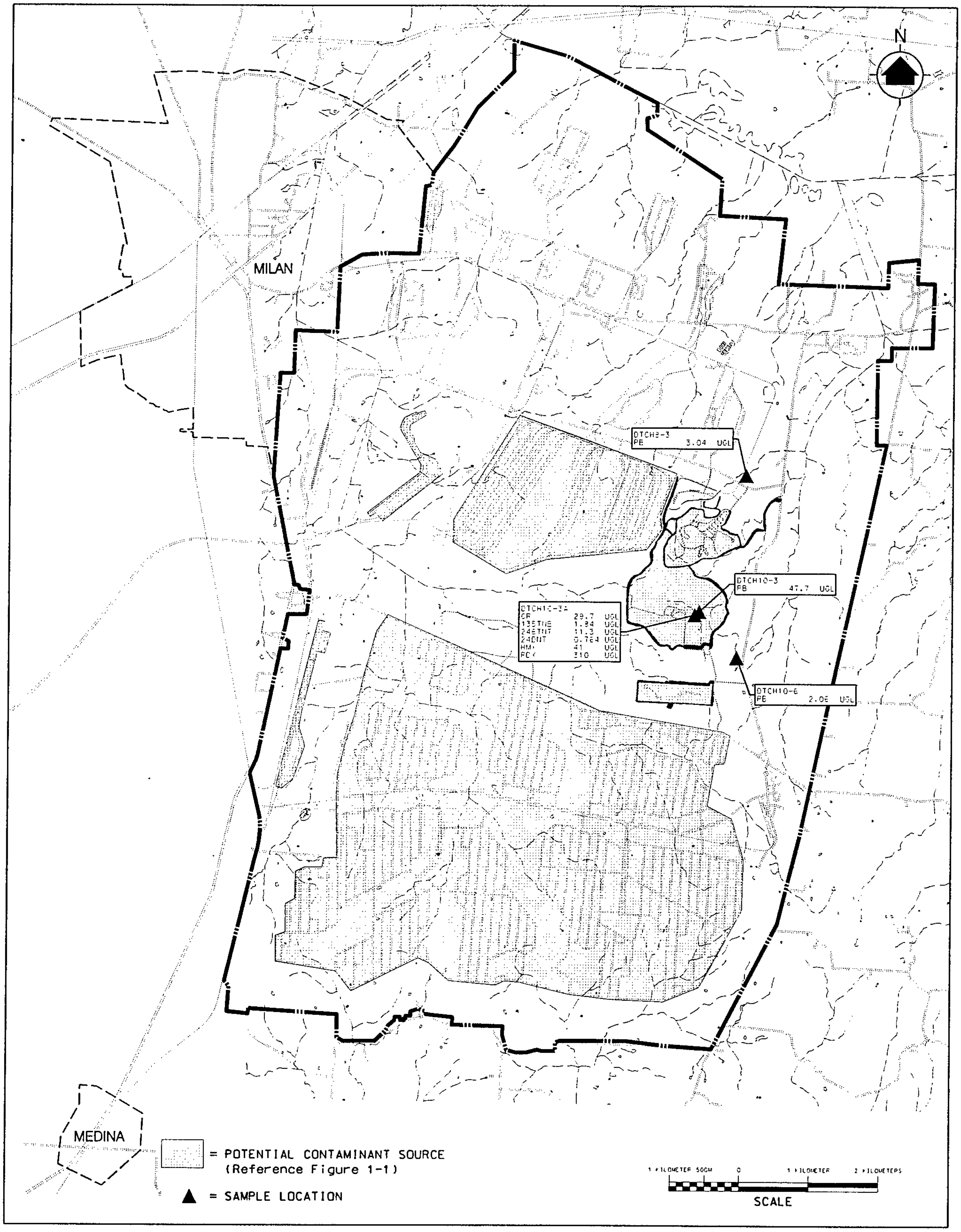


Figure 2-16. MLAAP Remedial Investigation (1991) Sediment Contamination Map

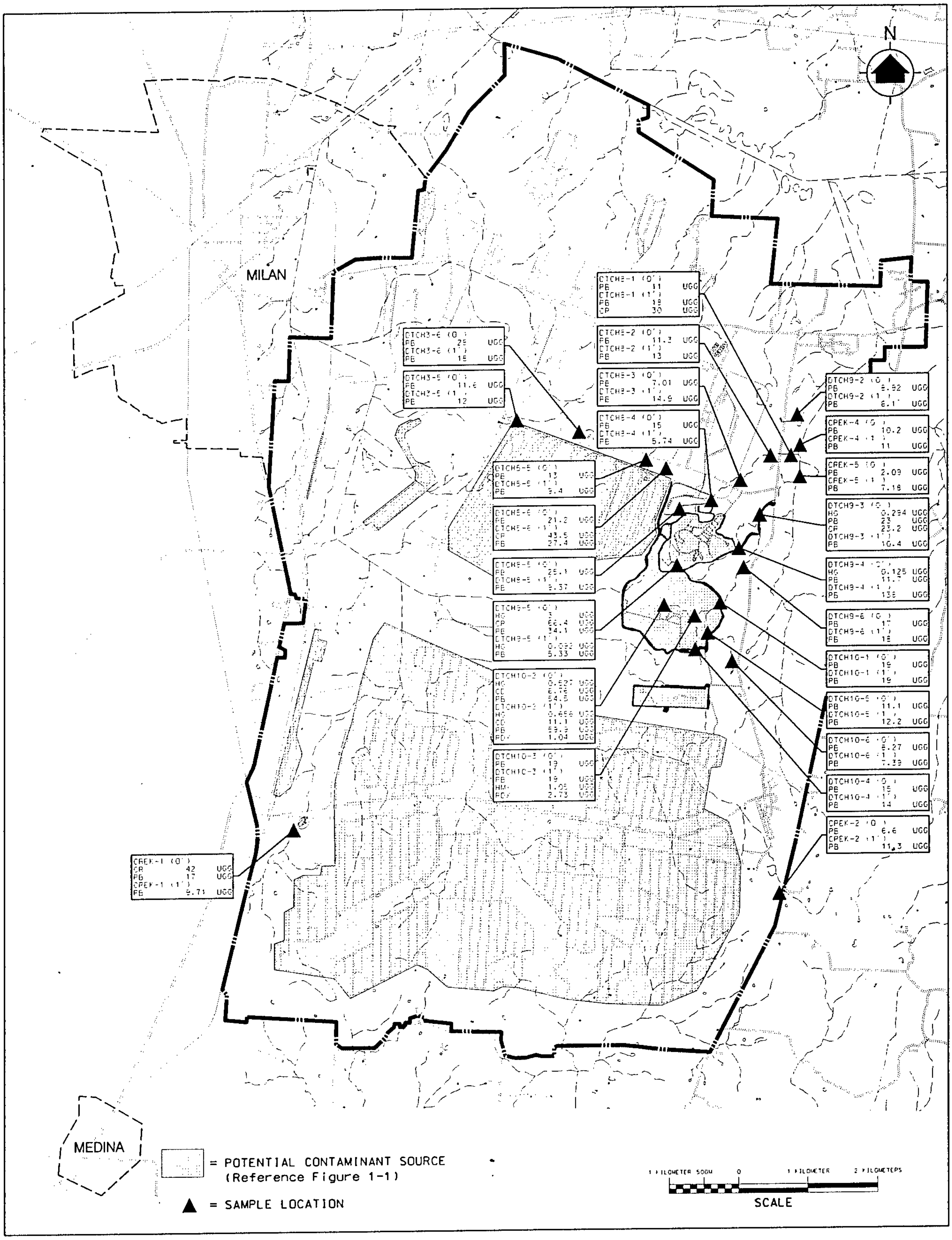


Figure 2-17. MLAAP Remedial Investigation (Operable Unit No. 4) Groundwater Piezometric Surface Map (June 1994)

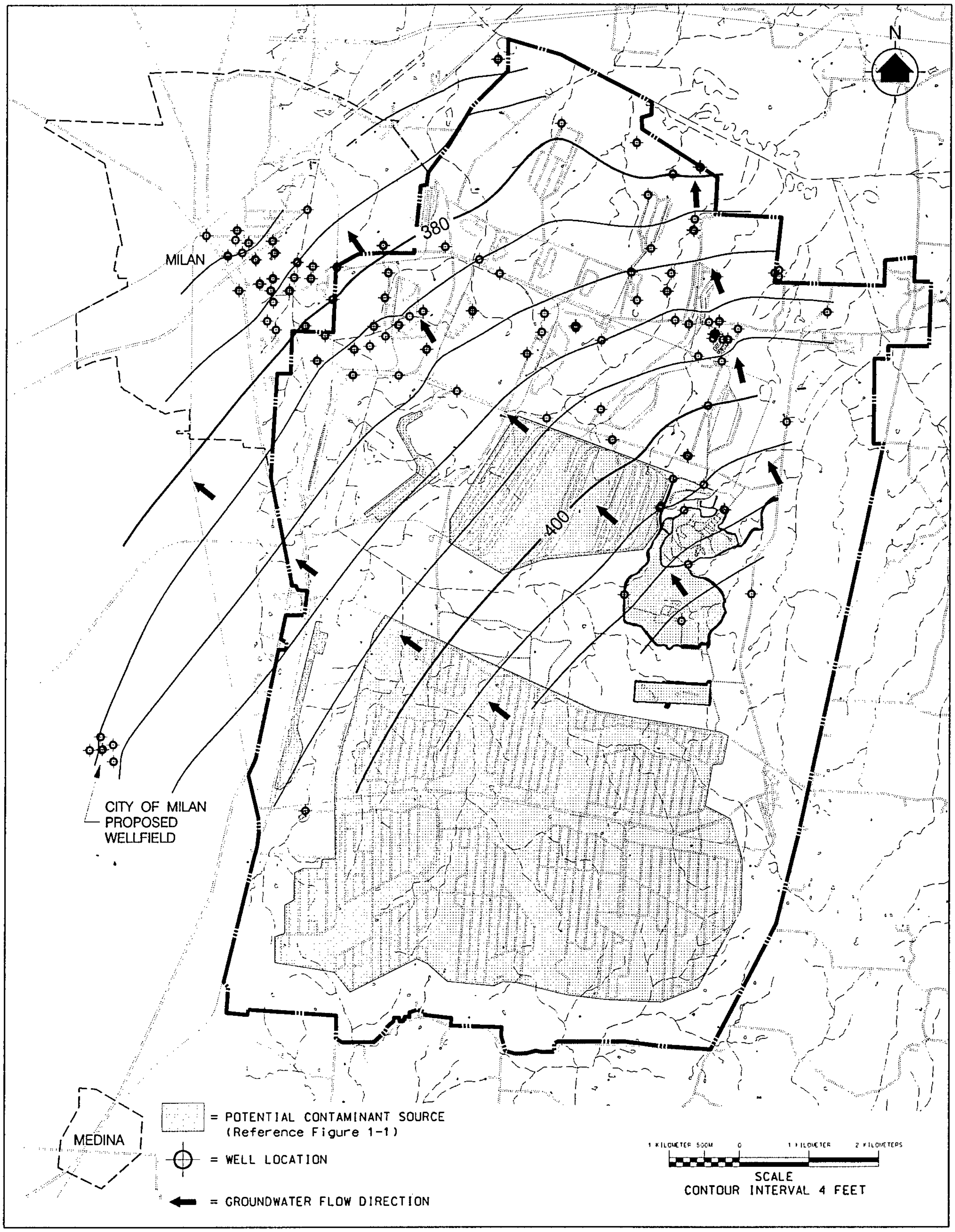
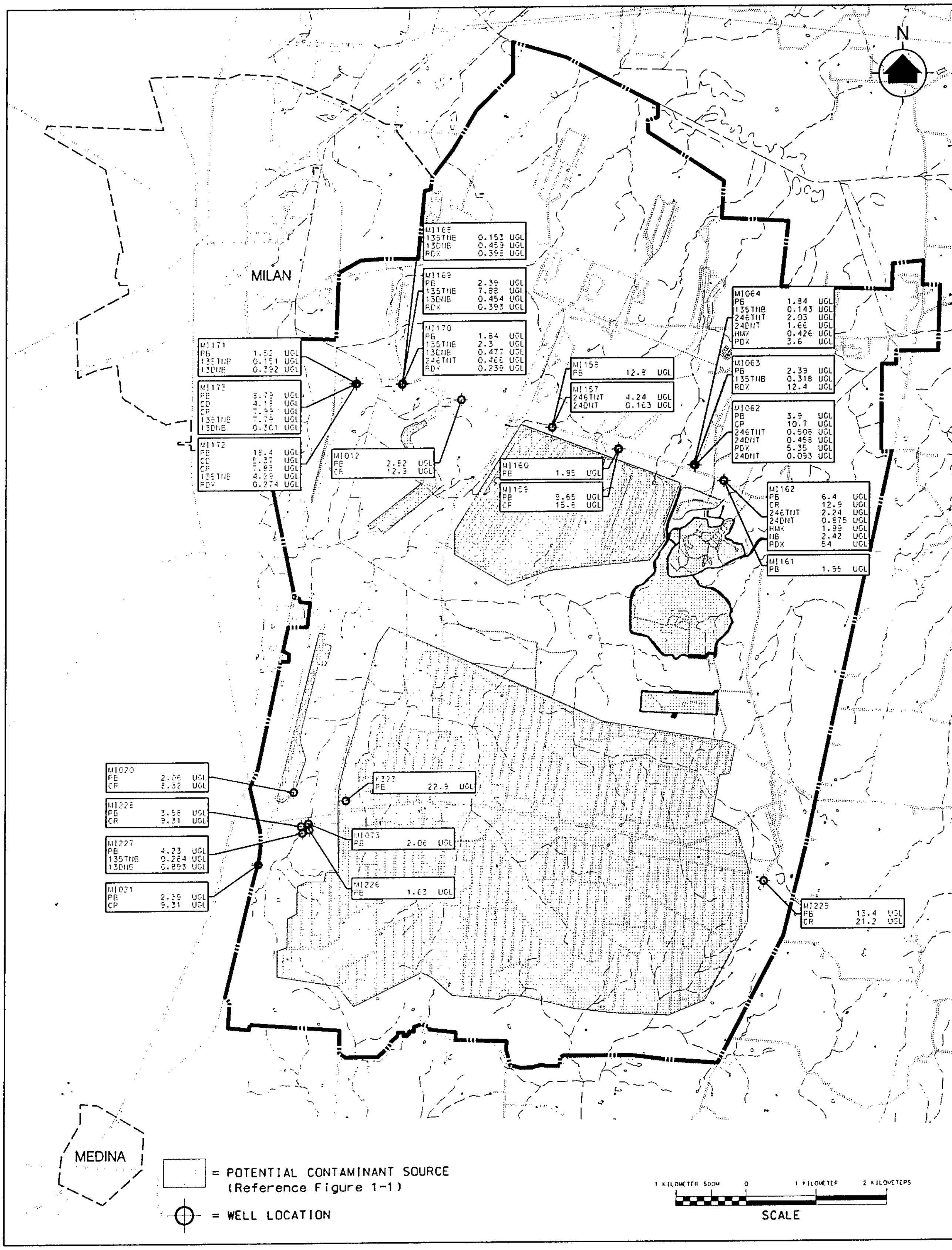


Figure 2-18. MLAAP Remedial Investigation (Operable Unit No. 4) Groundwater Contamination Map (1995)



2.5 Sampling Rationale

2.5.1 Open Burning Ground

Field data acquisition in the OBG has been designed to address the following concerns:

- identification of other disposal sites located within the OBG;
- limited verification sampling within selected disposal sites within the OBG;
- identification of sub-surface transport mechanisms responsible for transport of explosives contamination from surface/near-surface soil to groundwater;
- estimation of the relative contribution of contamination by each identified pathway to groundwater:
- additional groundwater contaminant plume definition; and
- additional surface water transport definition.

Quantification of other disposal sites located within the OBG

Extensive surface and sub-surface soil sampling & analysis has been conducted of disposal areas within the OBG (Figure 2-19). Metal ordnance debris was recently observed in areas located northwest and northeast of disposal area "B" located within the OBG. A controlled burn of heavy field brush in the OBG was conducted in February 1997 that revealed metallic ordnance debris apparently resulting from past open burning operations. These areas have not been investigated in prior field investigation efforts. Soil sampling of these areas will be conducted to access surficial contamination by nitrobodies (explosives) and selected heavy metals. Prior investigations conducted at the site indicate that cadmium (Cd), chromium (Cr), and lead (Pb) are present at low levels throughout the OBG. These metals are the selected heavy metals chosen for chemical analyses. Sample locations will be determined based upon the presence of ordnance debris and visible ground staining. Soil samples for chemical analyses (Table 2-4) will be collect at two depth increments per sample including a surficial increment (approximately 0 to 6 inches) and a lower increment (approximately 6 to 12 inches). Eight sample locations (16 sample increments) are planned to address these areas. Other field activities will consist of documenting (mapping) surficial extent of these areas via visual inspection & field measurements. All sampling activities will be performed with site clearance support personnel for unexploded ordnance (ESHI).

Results from surficial soil sampling and analyses will be evaluated to determine the need for additional sub-surface investigation consisting of soil borings with incremental sub-surface soil sampling & analyses for nitrobodies and selected heavy metals; in addition to installation of lysimeters. Sub-surface soil sampling & analyses will provide a profile of sub-surface soil contamination. Lysimeter installation will provide a sampling mechanism to collect water within the unsaturated (vadose zone) for chemical analyses consisting of nitrobodies and selected heavy metals; and determine if leaching of contaminants is occurring through the soil column into the groundwater table beneath disposal areas. In addition, lysimeters will also be installed immediately adjacent to Ditch 9 where the highest levels of nitrobodies have been detected in surface water within the OBG. Surface water drainage from disposal sites "E", "G" and "SH" flow into Ditch 9 and may migrate through the soil column into the groundwater flow system.

Figure 2-19. MLAAP Remedial Investigation Existing OBG Soil Samples Location Map

Table 2-4. MLAAP RI Southern Study Area
Surficial Soil Samples Summary

Contaminant Source Area	Site Type	Site ID	Total Depth (ft) (estimate)	Location
Open Burning Ground				
Outside Disposal Area "B"	GRAB	B001	0 to 6 inches 6 to 12 inches	Ordnance debris & ground stained area located northwest of Disposal Area "B". Possible past open burning activities are suspected within this area.
	GRAB	B002	0 to 6 inches 6 to 12 inches	Ordnance debris & ground stained area located northwest of Disposal Area "B". Possible past open burning activities are suspected within this area.
	GRAB	B003	0 to 6 inches 6 to 12 inches	Ordnance debris & ground stained area located northwest of Disposal Area "B". Possible past open burning activities are suspected within this area.
	GRAB	B004	0 to 6 inches 6 to 12 inches	Ordnance debris & ground stained area located northwest of Disposal Area "B". Possible past open burning activities are suspected within this area.
	GRAB	B005	0 to 6 inches 6 to 12 inches	Ordnance debris & ground stained area located northeast of Disposal Area "B". Possible past open burning activities are suspected within this area.
	GRAB	B006	0 to 6 inches 6 to 12 inches	Ordnance debris & ground stained area located northeast of Disposal Area "B". Possible past open burning activities are suspected within this area.
	GRAB	B007	0 to 6 inches 6 to 12 inches	Ordnance debris & ground stained area located northeast of Disposal Area "B". Possible past open burning activities are suspected within this area.
	GRAB	B008	0 to 6 inches 6 to 12 inches	Ordnance debris & ground stained area located northeast of Disposal Area "B". Possible past open burning activities are suspected within this area.
Disposal Area "A"	GRAB	A001	0 to 6 inches 6 to 12 inches	Disposal trenches located in this area that received ordnance related wastes from the mid-1960's to mid-1970's.
Disposal Area "B"	GRAB	B009	0 to 6 inches 6 to 12 inches	Ordnance debris & ground stained area located in Disposal Area "B". Past open burning activities occurred within this area from the 1942 to 1983.
Disposal Area "D"	GRAB	D001	0 to 6 inches 6 to 12 inches	Ordnance debris & ground stained area located in Disposal Area "D". Past open burning activities occurred within this area from the 1950's to mid-1970's.
Disposal Area "F"	GRAB	F001	0 to 6 inches 6 to 12 inches	Disposal trenches located in this area that received ordnance related wastes from the mid-1970's to 1983.
Disposal Area "SH"	GRAB	SH001	0 to 6 inches 6 to 12 inches	Burning/flashing area for ordnance related items.

Table 2-5. MLAAP RI Southern Study Area
Soil Borings Summary

Contaminant Source Area	Site Type	Site ID	Total Depth (ft) (estimate)	Location
Open Burning Ground				
Outside Disposal Area "B"	BORE	W029	70 feet	Ordnance debris & ground stained area located either northeast or northwest of Disposal Area "D". Possible past open burning activities are suspected within this area.
Disposal Area "A"	BORE	W030	70 feet	Disposal trenches located in this area that received ordnance related wastes from the mid-1960's to mid-1970's.
Disposal Area "B"	BORE	W031	70 feet	Ordnance debris & ground stained area located in Disposal Area "B". Past open burning activities occurred within this area from the 1942 to 1983.
Disposal Area "D"	BORE	W032	70 feet	Ordnance debris & ground stained area located in Disposal Area "D". Past open burning activities occurred within this area from the 1950's to mid-1970's.
Disposal Area "F"	BORE	W033	70 feet	Disposal trenches located in this area that received ordnance related wastes from the mid-1970's to 1983.
Ditch 9	BORE	W034	70 feet	Ditch 9 at confluence of drainage ditch discharging from disposal areas "E", "G", and "SH".

Table 2-6. MLAAP RI Southern Study Area
Lysimeter Summary

Contaminant Source Area	Site Type	Site ID	Total Depth (ft) (estimate)	Location
Open Burning Ground				
Outside Disposal Area "B"	LYSM	LY001	20 feet	Lysimeter to be installed using BORE W029
Disposal Area "A"	LYSM	LY002	10 feet	Lysimeter to be installed using BORE W030
	LYSM	LY003	20 feet	
	LYSM	LY004	40 feet	
	LYSM	LY005	70 feet	
Disposal Area "B"	LYSM	LY006	20 feet	Lysimeter to be installed using BORE W031
Disposal Area "D"	LYSM	LY007	10 feet	Lysimeter to be installed using BORE W032
	LYSM	LY008	20 feet	
	LYSM	LY009	40 feet	
	LYSM	LY010	70 feet	
Disposal Area "F"	LYSM	LY011	10 feet	Lysimeter to be installed using BORE W033
	LYSM	LY012	20 feet	
	LYSM	LY013	40 feet	
	LYSM	LY014	70 feet	
Ditch 9	LYSM	LY015	10 feet	Lysimeter to be installed using BORE W034
	LYSM	LY016	20 feet	
	LYSM	LY017	40 feet	
	LYSM	LY018	70 feet	

Installation of a lysimeter cluster at this location will provide a sampling mechanism to determine if contamination is entering groundwater through drainage ditches located within the OBG. Soil borings (extending to the groundwater table) (Table 2-5) and lysimeter installations (Table 2-6), with associated chemical sampling & analyses are currently planned for each of these areas.

Limited verification sampling within selected disposal sites within the OBG

Investigations conducted within the OBG including the Investigation and Engineering Analysis for Remedial Actions, Milan Army Ammunition Plant Open Burning Ground Report and the ongoing RI have identified disposal areas "A", "B", "D", "F", and "SH" as containing the higher levels of nitrobodies in soils (Figure 2-20 & Table 2-7). All of these disposal areas exhibit groundwater contamination by nitrobodies. Limited sampling & analyses will be conducted in these areas to verify earlier chemical analyses results. Surficial soil samples collected for chemical analyses during the earlier RI field efforts were collocated with soil borings that were offset immediately adjacent from areas containing heavy metallic ordnance debris. Sample locations for this addendum will be determined based upon the presence of ordnance debris and visual ground staining, or suspected historical use of the area. Soil samples for analysis will be collect at two depth increments per sample including a surficial increment (approximately 0 to 6 inches) and a lower increment (approximately 6 to 12 inches). Five sample locations (10 sample increments) are planned to address these areas. Other field activities will consist of documenting (mapping) surficial extent of these areas via visual inspection & field measurements. All sampling activities will be performed with site clearance support personnel for unexploded ordnance (ESHI).

Results from surficial soil sampling and analyses will be evaluated to determine the need for additional sub-surface investigation consisting of soil borings with incremental sub-surface soil sampling & analyses for nitrobodies and selected heavy metals; in addition to installation of lysimeters. Sub-surface soil sampling & analyses will provide a profile of sub-surface soil contamination. Lysimeter installation will provide a sampling mechanism to collect water within the unsaturated (vadose zone) for chemical analyses consisting of nitrobodies and selected heavy metals; and determine if leaching of contaminants is occurring through the soil column into the groundwater table beneath disposal areas. Five soil borings (extending to the groundwater table) (Table 2-5), with associated chemical sampling & analyses are currently estimated.

Quantification of sub-surface transport mechanisms responsible for transport of explosives contamination from surface/near-surface soil to groundwater

Results from the Draft MLAAP RI Southern Study Area (Operable Unit No. 5) Report indicate the presence of an extensive groundwater plume beneath the OBG consisting of nitrobodies (Figures 2-21 a. through c.) , however, chemical analytical results from sub-surface soil samples from soil borings do not indicate extensive nitrobodies contamination within the sub-surface soil matrix. These results suggest several possibilities (or combinations) regarding transport of nitrobodies from disposal areas into groundwater:

Figure 2-20. MLAAP Remedial Investigation
Disposal Sites "A", "B", "D", "F", & "SH" Existing Soil Sample Locations

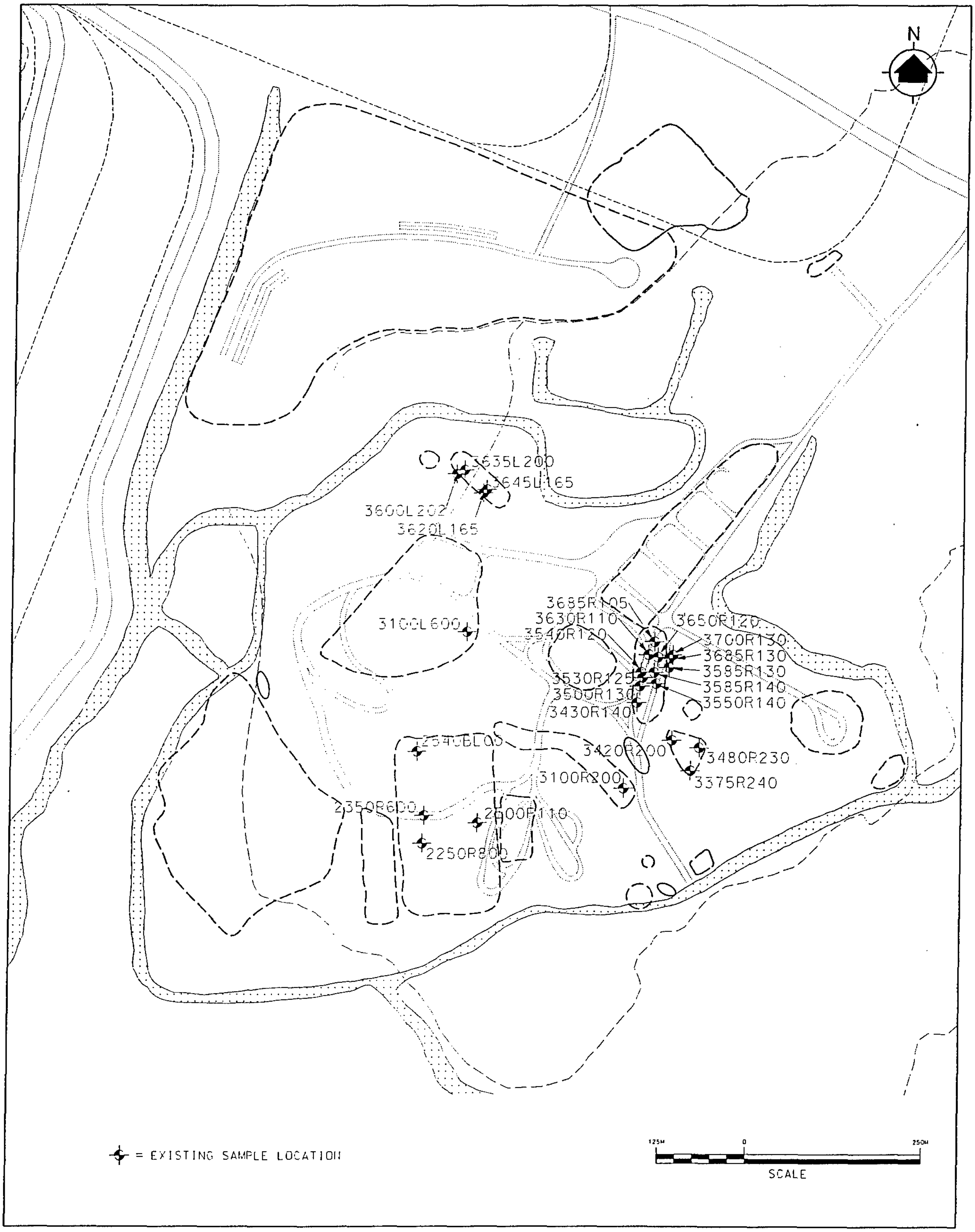


Table 2-7. Maap
Disposal Sites "A", "B", "F", & "S

site_type	site_id	depth	samp_date	Nitrobodies (explosive compounds)						
				135TNB	13DNB	246TNT	24DNT	26DNT	2A46DT	2NT
Open Burning Ground (disposal Area "A")										
BORE	3600L202	4	Jul-Aug 87	0.275	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3600L202	8		1.630	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3620L165	1	Jul-Aug 87	ND 0.2	ND 0.2	0.259	ND 0.2	ND 0.2	---	---
BORE	3620L165	8		ND 0.2	ND 0.2	ND 0.2	ND 0.2	0.230	---	---
BORE	3635L200	4	Jul-Aug 87	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3635L200	13		ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3645L165	1	Jul-Aug 87	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3645L165	19		ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
Open Burning Ground (Disposal Area "B")										
BORE	3100L600	1	Jul-Aug 87	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
Open Burning Ground (Disposal Area "D")										
BORE	2250R800	0.5	Jul-Aug 87	ND 0.2	ND 0.2	ND 0.2	ND 0.2	0.463	---	---
BORE	2250R800	4		ND 0.2	ND 0.2	ND 0.2	ND 0.2	0.304	---	---
BORE	2350R600	2	Jul-Aug 87	ND 0.2	ND 0.2	0.230	0.244	0.276	---	---
BORE	2350R600	6		ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	2500R110	0.5	Jul-Aug 87	ND 0.2	ND 0.2	ND 0.2	ND 0.2	0.313	---	---
BORE	2500R110	6		ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	2540BL00	0.5	Jul-Aug 87	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	2540BL00	19		ND 0.2	ND 0.2	ND 0.2	ND 0.2	0.344	---	---
Open Burning Ground (Disposal Area "F")										
BORE	3430R140	5	Jul-Aug 87	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3430R140	15		ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3500R130	2	Jul-Aug 87	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3500R130	6		ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3500R130	8	Jul-Aug 87	ND 0.2	ND 0.2	0.609	ND 0.2	ND 0.2	---	---
BORE	3530R125	4		ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---

Table 2-7. Maap RI Southern Study Area
sal Sites "A", "B", "F", & "SH" Soil Chemical Analytical Results ($\mu g/g$)

										Metals: Group 1		
A46DT	2NT	34DNT	3NT	4A26DT	4NT	HMX	NB	RDX	TETRYL	CD	CR	HG
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	5.010	16.100	---
---	---	---	---	---	---	ND 0.2	ND 0.2	0.307	ND 0.2	104.000	53.100	---
---	---	---	---	---	---	ND 0.2	ND 0.2	0.596	ND 0.2	69.000	69.900	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	0.111	11.300	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	72.100	379.000	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	4.050	29.200	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	139.000	127.000	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.1	5.720	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	227.000	12.700	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	0.342	0.144	2.130	---
---	---	---	---	---	---	ND 0.2	ND 0.2	0.466	0.262	0.105	2.250	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	0.294	ND 0.1	2.450	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	0.295	ND 0.1	16.800	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	2.350	29.300	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	0.252	21.600	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	0.249	0.341	17.800	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	0.292	0.184	9.840	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	2.570	16.900	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	26.200	23.700	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	17.700	47.100	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	24.900	65.200	---
---	---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	21.900	84.700	---
---	---	---	---	---	---	2.340	ND 0.2	18.500	ND 0.2	12.700	65.200	---

2

				Metals: Group 1			
	NB	RDX	TETRYL	CD	CR	HG	PB
.2	ND 0.2	ND 0.2	ND 0.2	5.010	16.100	---	15.500
.2	ND 0.2	0.307	ND 0.2	104.000	53.100	---	327.000
.2	ND 0.2	0.596	ND 0.2	69.000	69.900	---	1480.000
.2	ND 0.2	ND 0.2	ND 0.2	0.111	11.300	---	6.950
.2	ND 0.2	ND 0.2	ND 0.2	72.100	379.000	---	2960.000
.2	ND 0.2	ND 0.2	ND 0.2	4.050	29.200	---	218.000
.2	ND 0.2	ND 0.2	ND 0.2	139.000	127.000	---	1340.000
.2	ND 0.2	ND 0.2	ND 0.2	ND 0.1	5.720	---	3.440
.2	ND 0.2	ND 0.2	ND 0.2	227.000	12.700	---	23.900
).2	ND 0.2	ND 0.2	0.342	0.144	2.130	---	8.670
).2	ND 0.2	0.466	0.262	0.105	2.250	---	8.630
).2	ND 0.2	ND 0.2	0.294	ND 0.1	2.450	---	14.500
).2	ND 0.2	ND 0.2	0.295	ND 0.1	16.800	---	6.780
0.2	ND 0.2	ND 0.2	ND 0.2	2.350	29.300	---	84.500
0.2	ND 0.2	ND 0.2	ND 0.2	0.252	21.600	---	6.450
0.2	ND 0.2	ND 0.2	0.249	0.341	17.800	---	274.000
0.2	ND 0.2	ND 0.2	0.292	0.184	9.840	---	5.460
0.2	ND 0.2	ND 0.2	ND 0.2	2.570	16.900	---	53.200
0.2	ND 0.2	ND 0.2	ND 0.2	26.200	23.700	---	40.100
0.2	ND 0.2	ND 0.2	ND 0.2	17.700	47.100	---	605.000
0.2	ND 0.2	ND 0.2	ND 0.2	24.900	65.200	---	1810.000
0.2	ND 0.2	ND 0.2	ND 0.2	21.900	84.700	---	1560.000
340	ND 0.2	18.500	ND 0.2	12.700	65.200	---	469.000

3

Table 2-7 Maap
Disposal Sites "A", "B", "F", & "S

site_type	site_id	depth	samp_date	Nitrobodies (explosive compounds)						
				135TNB	13DNB	246TNT	24DNT	26DNT	2A46DT	2NT
BORE	3530R125	7	Jul-Aug 87	ND 0.2	ND 0.2	0.908	ND 0.2	ND 0.2	---	---
BORE	3540R120	4	Jul-Aug 87	ND 0.2	ND 0.2	14.000	2.460	ND 0.2	---	---
BORE	3540R120	8		ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3550R140	14.8	Jul-Aug 87	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3585R130	4	Jul-Aug 87	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3585R130	8		ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3630R110	2	Jul-Aug 87	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3630R110	4		ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3650R120	4	Jul-Aug 87	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3685R105	2		ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3685R105	15		ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
Open Burning Ground (Disposal Area "SH")										
BORE	3375R240	4	Jul-Aug 87	ND 0.2	ND 0.2	0.281	ND 0.2	ND 0.2	---	---
BORE	3375R240	8		ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3375R240	12		ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3420R200	4	Jul-Aug 87	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3420R200	12		ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	---	---
BORE	3480R230	4	Jul-Aug 87	0.644	ND 0.2	204.000	ND 0.2	ND 0.2	---	---
BORE	3480R230	12		3.750	ND 0.2	153.000	ND 0.2	ND 0.2	---	---

Table 2-7. Maap RI Southern Study Area
"A", "B", "F", & "SH" Soil Chemical Analytical Results ($\mu g/g$)

									Metals: Group 1			
2NT	34DNT	3NT	4A26DT	4NT	HMX	NB	RDX	TETRYL	CD	CR	HG	PB
---	---	---	---	---	46.700	ND 0.2	301.000	ND 0.2	33.400	60.700	---	1530.0
---	---	---	---	---	17.300	ND 0.2	302.000	0.476	2.290	21.700	---	59.2
---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	0.103	9.720	---	4.0
---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	0.507	9.750	---	4.7
---	---	---	---	---	ND 0.2	ND 0.2	0.322	ND 0.2	101.000	78.700	---	642.0
---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	8.050	0.847	---	41.6
---	---	---	---	---	1.350	ND 0.2	3.830	ND 0.2	9.950	19.600	---	77.8
---	---	---	---	---	ND 0.2	ND 0.2	0.925	ND 0.2	2.600	18.100	---	54.6
---	---	---	---	---	0.266	ND 0.2	0.535	ND 0.2	37.100	59.200	---	1760.0
---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	1.330	17.600	---	101.0
---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.1	2.340	---	2.21
---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.1	17.600	---	2.47
---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.1	21.200	---	4.80
---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.1	11.200	---	3.62
---	---	---	---	---	ND 0.2	ND 0.2	ND 0.2	ND 0.2	0.147	18.800	---	4.41
---	---	---	---	---	ND 0.2	ND 0.2	0.322	ND 0.2	ND 0.1	20.000	---	3.45
---	---	---	---	---	ND 0.2	ND 0.2	0.636	ND 0.2	84.000	28.000	---	22.00
---	---	---	---	---	0.551	ND 0.2	2.520	ND 0.2	4.860	10.500	---	3.90

2

			Metals: Group 1			
NB	RDX	TETRYL	CD	CR	HG	PB
ND 0.2	301.000	ND 0.2	33.400	60.700	---	1530.000
ND 0.2	302.000	0.476	2.290	21.700	---	59.200
ND 0.2	ND 0.2	ND 0.2	0.103	9.720	---	4.090
ND 0.2	ND 0.2	ND 0.2	0.507	9.750	---	4.740
ND 0.2	0.322	ND 0.2	101.000	78.700	---	642.000
ND 0.2	ND 0.2	ND 0.2	8.050	0.847	---	41.600
ND 0.2	3.830	ND 0.2	9.950	19.600	---	77.800
ND 0.2	0.925	ND 0.2	2.600	18.100	---	54.600
ND 0.2	0.535	ND 0.2	37.100	59.200	---	1760.000
ND 0.2	ND 0.2	ND 0.2	1.330	17.600	---	101.000
ND 0.2	ND 0.2	ND 0.2	ND 0.1	2.340	---	2.210
ND 0.2	ND 0.2	ND 0.2	ND 0.1	17.600	---	2.470
ND 0.2	ND 0.2	ND 0.2	ND 0.1	21.200	---	4.800
ND 0.2	ND 0.2	ND 0.2	ND 0.1	11.200	---	3.620
ND 0.2	ND 0.2	ND 0.2	0.147	18.800	---	4.410
ND 0.2	0.322	ND 0.2	ND 0.1	20.000	---	3.450
ND 0.2	0.636	ND 0.2	84.000	28.000	---	22.000
ND 0.2	2.520	ND 0.2	4.860	10.500	---	3.900

3

Figure 2-21 (a). MLAAP Remedial Investigation OBG/Former & Current ADAs/ATA Groundwater (upper) Contamination

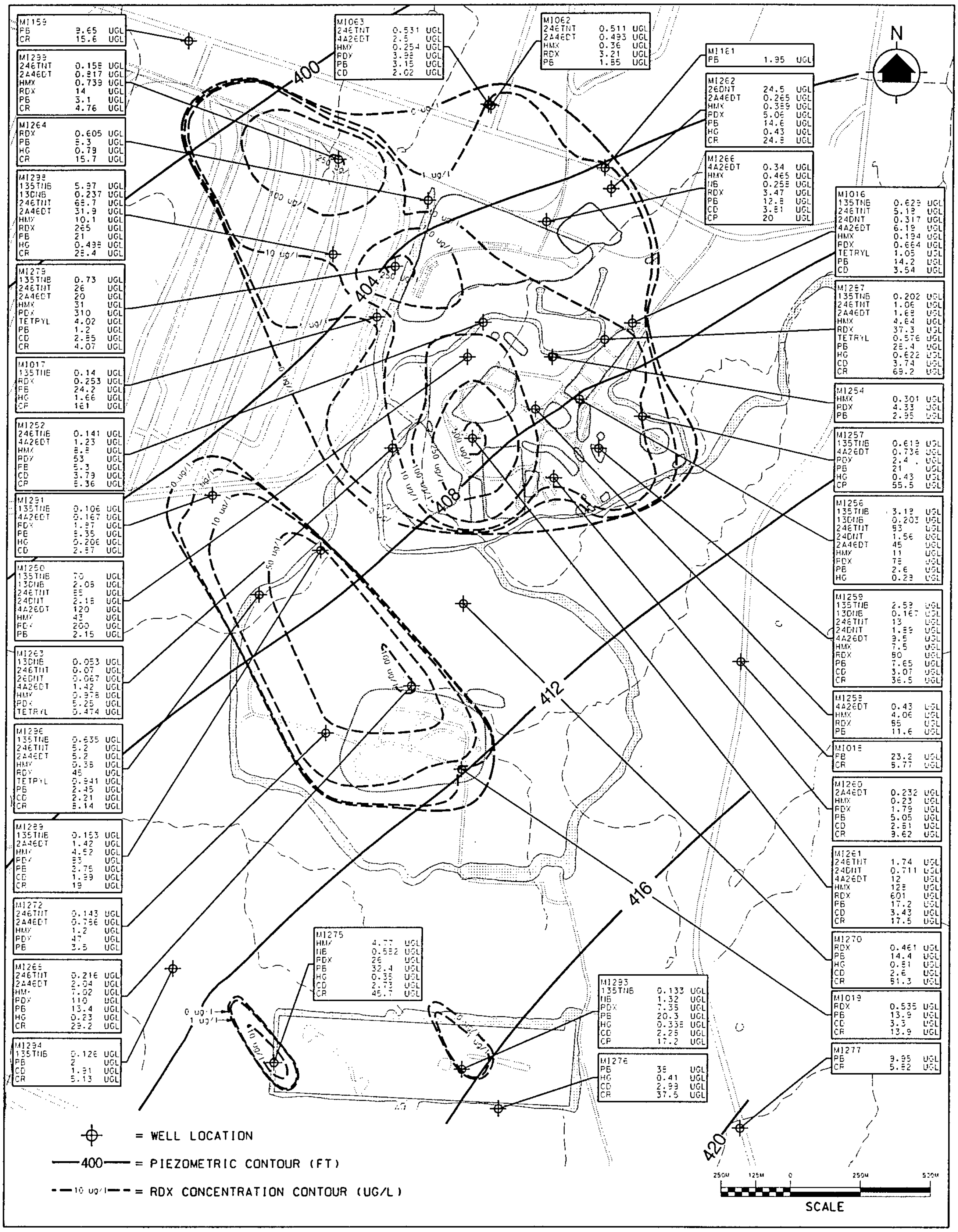


Figure 2-21 (b). MLAAP Remedial Investigation OBG/Former & Current ADAs/ATA Groundwater (middle) Contamination

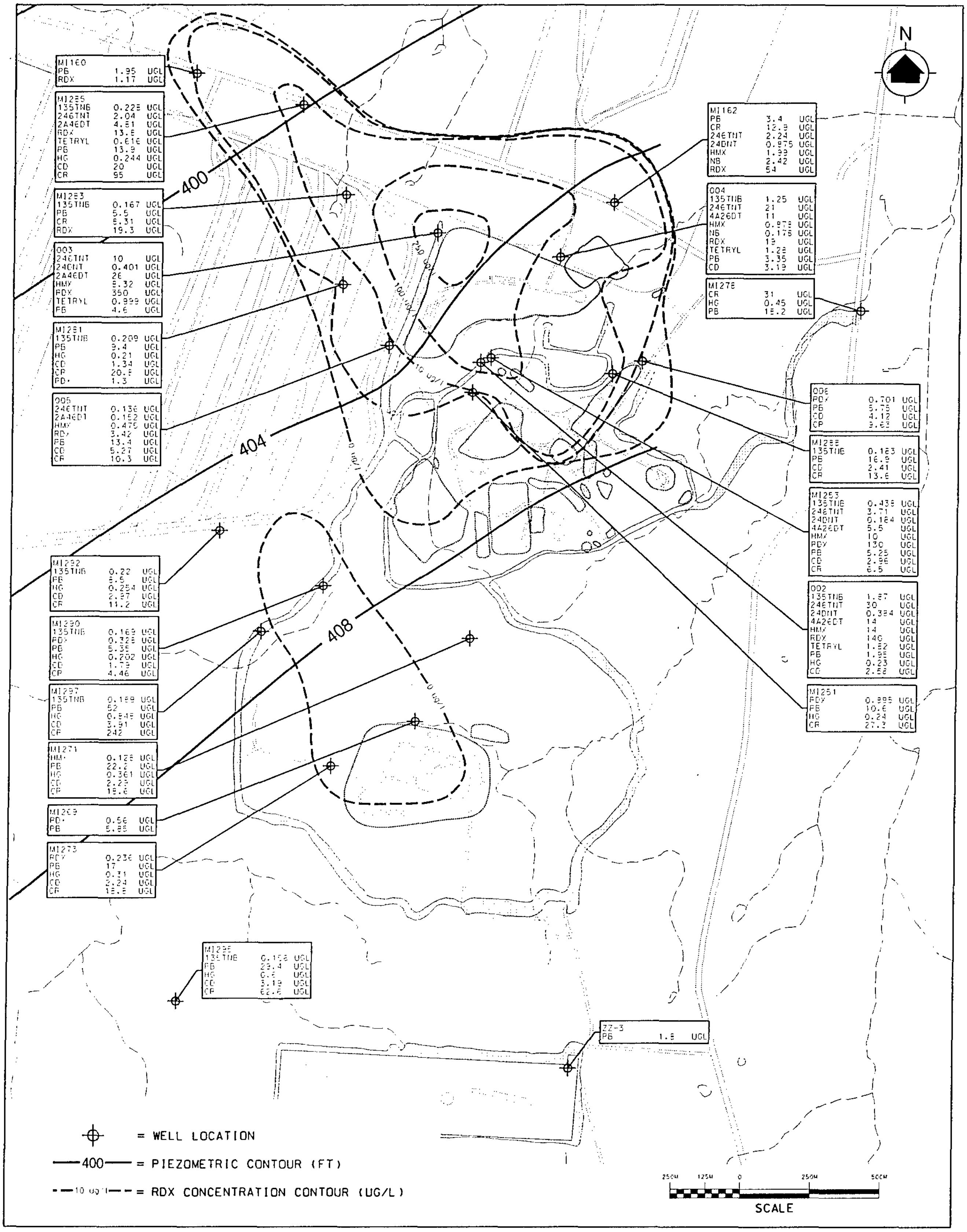
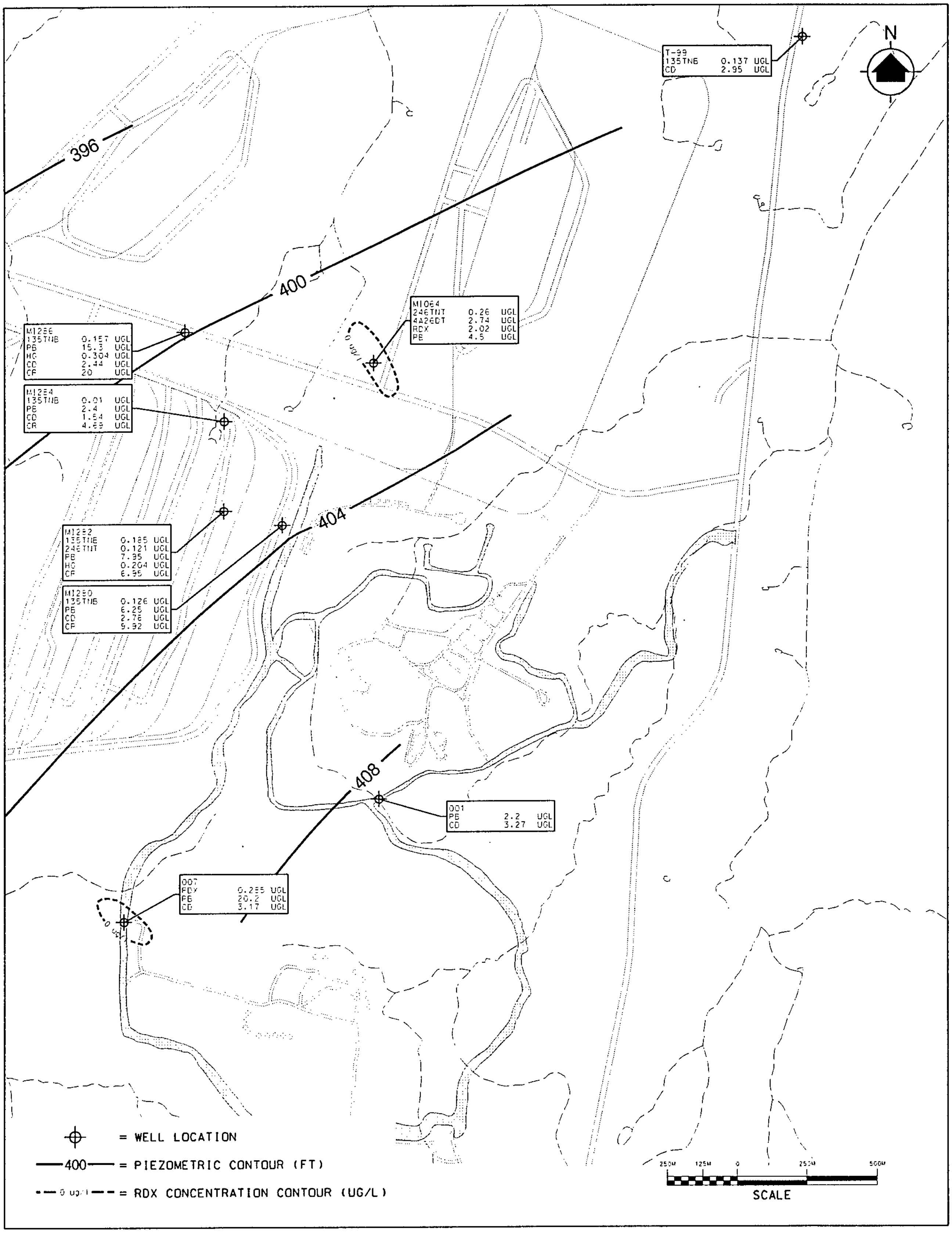


Figure 2-21 (c). MLAAP Remedial Investigation
OBG/Former & Current ADAs/ATA Groundwater (deep) Contamination



- nitrobodies have either degraded within the undisturbed soil column and are no longer present;
- nitrobodies have leached through the undisturbed soil column and entered the saturated groundwater flow system; or
- nitrobodies are present within the undisturbed soil column, but are at levels below the certified detection limit of the chemical analytical method(s) employed (soil matrix) or have not been quantified (water within the unsaturated zone).

No previous efforts have been conducted to quantify contaminants in water within the unsaturated zone. Quantification of nitrobodies and selected heavy metals in water within the unsaturated zone should provide data to determine how contaminants are reaching the saturated groundwater flow system. Placement of lysimeters at multiple depths within the soil column at locations where ordnance related disposal activities have occurred will provide data regarding contaminant levels within water in the vadose zone that percolates into the saturated groundwater flow system. Three (3) clusters of lysimeters installed at approximately 10, 20, 40, and 70 feet below ground surface will be installed in disposal sites "A", "D", and "F". The depth to the groundwater table is approximately 80 to 100 feet in depth. One lysimeter each will be also be installed within and outside disposal site "B". A lysimeter cluster will also be installed adjacent to Ditch 9 at the confluence of the drainage ditch discharging from disposal areas "E", "G", and "SH". This location was identified in the RI to exhibit the highest levels of RDX in surface water and may provide a pathway for contamination to migrate into the groundwater flow system via infiltration into and percolation through the soil column underlaying Ditch 9. Ditch 9 exhibits sandy reaches that suggest a possible migration pathway for contaminants to enter the groundwater system. Eighteen lysimeter installations located within the six soil borings, with associated chemical sampling & analyses are currently estimated (Table 2-6 and Figure 2-22).

<u>Additional groundwater contaminant plume definition</u>

Additional groundwater plume definition is proposed for both the OBG and former ADA. One shallow monitoring well is proposed down-gradient of groundwater flow from Ditch 9 and up-gradient of any disposal areas located within the ADA (Table 2-8 & Figure 2-22). This well placement will provide chemical analytical data to determine whether Ditch 9 is a pathway for contaminants to enter the groundwater flow system at the OBG.

<u>Additional surface water transport definition</u>

Surface water contamination by nitrobodies were quantified during the RI for the OBG. Ditch 9 was found to contain nitrobodies (Table 2-9 & Figure 2-23) at sample locations located within the OBG and extending to the confluence of Ditch 9 and Halls Branch of Johns Creek. Additional samples for chemical analyses for nitrobodies and selected heavy metals are required to determine if any contaminant discharges are occurring into Halls Branch of Johns Creek. Two samples are proposed that will be collected during a storm event, since Ditch 9 is usually dry except during storm periods.

Table 2-8. MLAAP RI Southern Study Area
Groundwater Monitoring Well Summary

Contaminant Source Area	Site Type	Site ID	Aquifer Zone	Total Depth (ft) (estimate)	Location
Open Burning Ground					
	WELL	MI412	Shallow	100 feet	Upgradient of the OBG and inside Ditch 9
Former Ammunition Destruction Area					
	WELL	MI413	Shallow	140 feet	Downgradient of the OBG inside Area "L"
		MI414	Middle	210 feet	

Table 2-9. MLAAP RI Southern Study Area
Surface Water/Sediment Samples Summary

Contaminant Source Area	Site Type	Site ID	Sample Matrix	Location
Open Burning Ground				
	CREK	33SW01 33SE01	Surface Water Sediment	Halls Branch of Johns Creek downstream of confluence with Ditch 9. Monitor surface water/sediment quality potentially impacted by the OBG. Sampling must be conducted during storm events when Ditch 9 discharges into creek.
	CREK	33SW02 33SE02	Surface Water Sediment	Halls Branch of Johns Creek downstream of 33SW01/33SE01. Monitor surface water/sediment quality potentially impacted by the OBG. Sampling must be conducted during storm events when Ditch 9 discharges into creek.

Figure 2-22. MLAAP RI Southern Study Area
OBG/Former ADA Monitoring Well/Lysimeter Locations

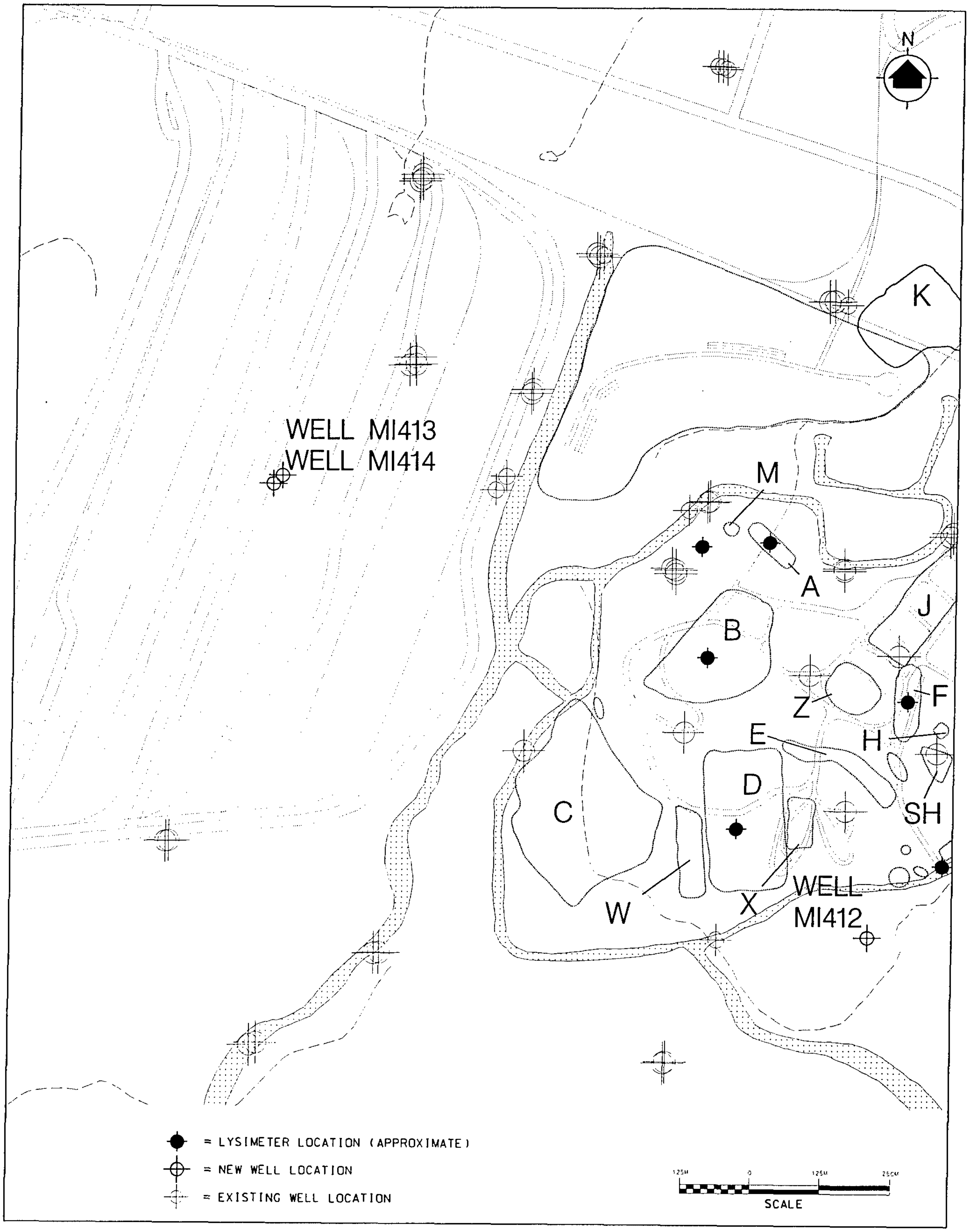
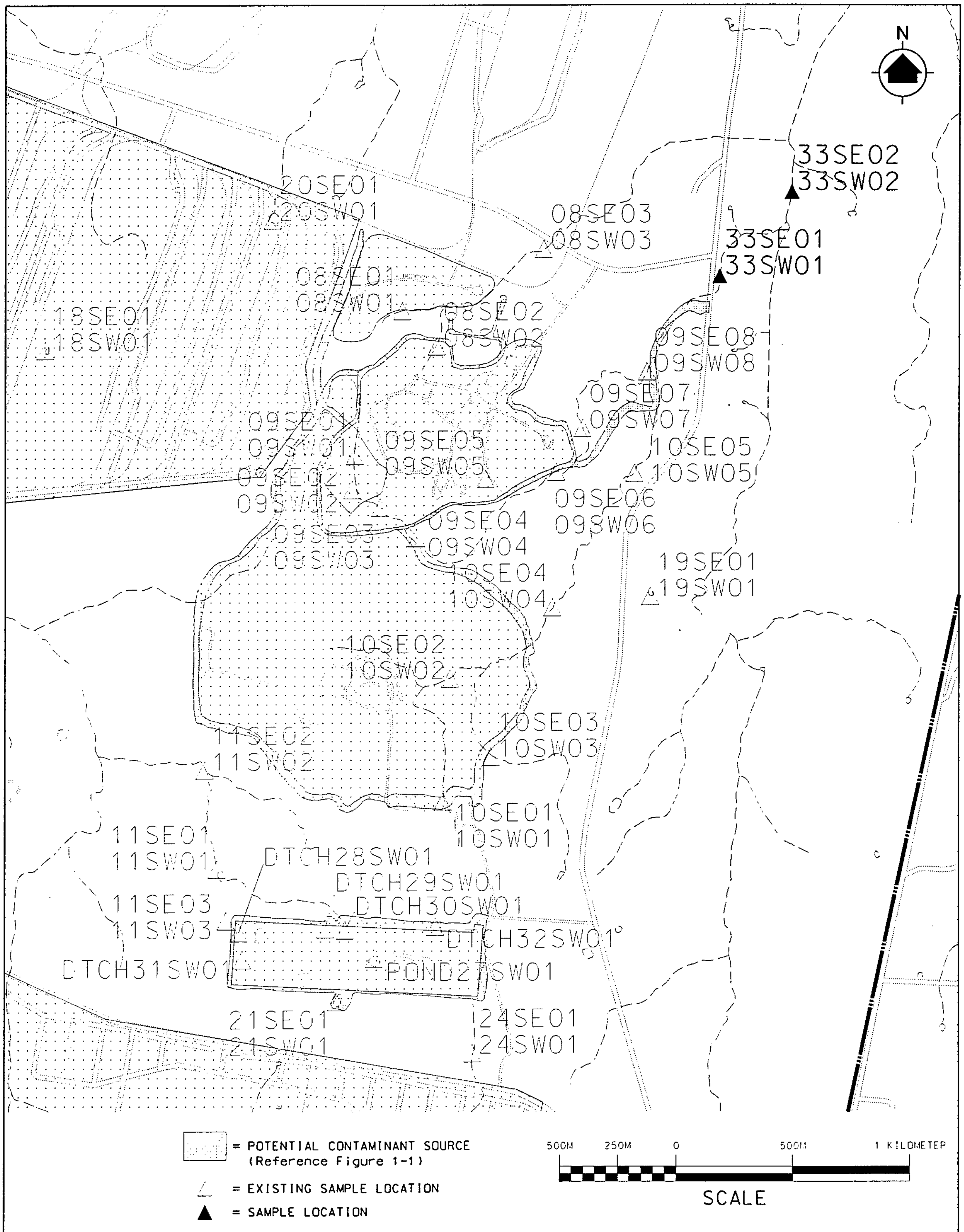


Figure 2-23. MLAAP RI Southern Study Area
Surface Water/Sediment Sample Locations



2.5.2 Former Ammunition Destruction Area

Field data acquisition in the former ADA has been designed to address the following concerns:

- additional groundwater contaminant plume definition.

Two monitoring wells consisting of a shallow and middle depths are proposed to quantify down-gradient contamination from the former ADA. Shallow groundwater contamination was found adjacent to the former ADA, however, no additional down-gradient wells were drilled in prior efforts to determine further contaminant migration. The proposed wells will be placed approximately 1,000 meters down-gradient of groundwater flow (Table 2-8 & Figure 2-22). This location is within the estimated groundwater contaminant migration travel path distance for the OBG using a contaminant migrate rate ($\bar{v}$) of 0.3 to 0.5 feet/day. Disposal occurred within this area approximately 50 years ago (1940's) and contaminants could have migrated over 6,000 feet in groundwater.

2.5.3 Off-Site Areas

Groundwater sampling and analyses has been conducted down-gradient of groundwater flow from the MLAAP Southern Study Area (Figure 2-24 and Table 2-10). These results indicate no detectable levels of nitrobodies from the MLAAP Southern Study Area. Results of these analyses will be compared to groundwater modeling results currently in progress under the RI effort. Well screen depths will be obtained (if available) and evaluated against groundwater modeling results to determine if wells could be impacted from any groundwater contaminant transport (if any) identified by modeling efforts. The nearest potential contaminant source adjacent to these wells on MLAAP is the Closed Ammunition Burnout Area (ABA). Results of groundwater sampling and analyses indicate the presence of nitrobodies below current HAs.

Figure 2-24. MLAAP RI Southern Study Area
Off-Site Groundwater Contamination Map

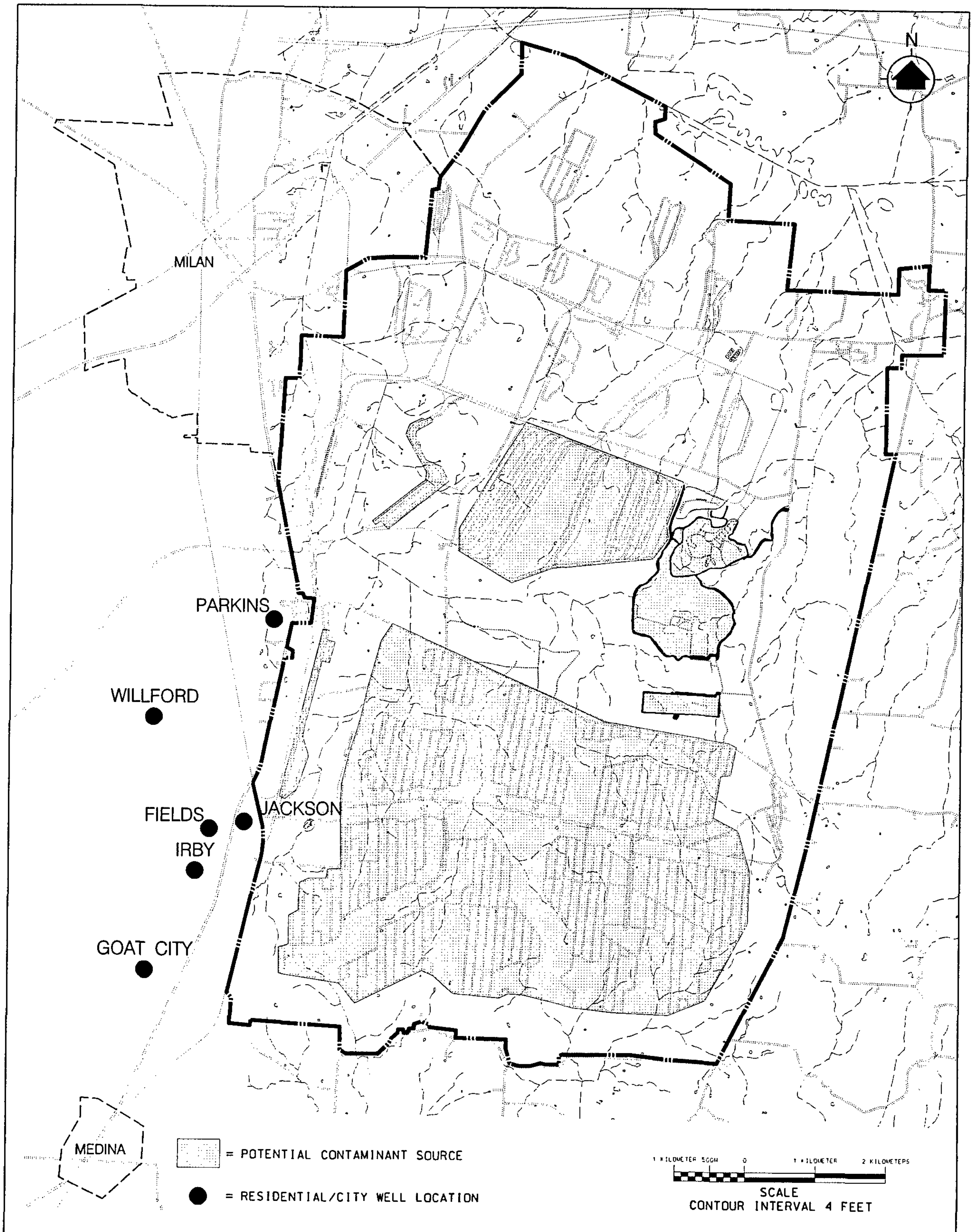


Table 2-10. MLAAP RI Southern Study Area
Off-Site Groundwater Chemical Analytical Results ($\mu g/l$)

site_type	site_id	sample_date	Nitrobodies							Metals			
			135TNB	24DNT	26DNT	246TNT	HMX	RDX	TETRYL	CD	CR	HG	PB
Well	Denton Parkins	08-Mar-94	LT 0.1	LT 0.04	LT 0.003	LT 0.06	LT 6.0	LT 0.14	---	---	---	---	---
Well	Shane Willford	08-Mar-94	LT 0.1	LT 0.04	LT 0.003	LT 0.06	LT 6.0	LT 0.14	---	---	---	---	---
Well	Charles Fields	08-Mar-94	LT 0.1	LT 0.04	LT 0.003	LT 0.06	LT 6.0	LT 0.14	---	---	---	---	---
Well	Fred Irby	08-Mar-94	LT 0.1	LT 0.04	LT 0.003	LT 0.06	LT 6.0	LT 0.14	---	---	---	---	---
Well	Goat City (North)	24-Jan-94	ND (0.1)	ND (0.1)	ND (0.007)	ND (0.1)	ND (8.0)	ND (0.3)	---	---	---	---	---
Well	Goat City (South)	24-Jan-94	ND (0.1)	ND (0.1)	ND (0.007)	ND (0.1)	ND (8.0)	ND (0.3)	---	---	---	---	---
Well	Timothy Jackson 301 Medina Hwy	16-Feb-93	ND (0.1)	ND (0.1)	ND (0.007)	ND (0.1)	ND (8.0)	ND (0.3)	---	---	---	---	---
Well	TEST01	03-Aug-94	LT 0.1	LT 0.04	LT 0.003	LT 0.06	LT 6.0	LT 0.14	---	---	---	---	---

Note: "( )" indicates the method dection limit.
ND - Non-detection

3.0 FIELD INVESTIGATION METHODOLOGY

The following section presents the technical methodology to be used during field investigation addendum activities. These activities included sampling support operations, unexploded ordnance (UXO) clearance, soil boring and subsurface soil sampling, lysimeter and groundwater monitoring well installations, groundwater sampling, geohydrological data collection (i.e., physical soil parameter identification, physical soil sample collection, and groundwater depth measurements), surface soil sampling, and surface water and sediment sampling.

Field investigation methodology to be utilized for the site complies with all USAEC and USEPA Region IV geotechnical and quality assurance/quality control (QA/QC) requirements as reflected by the approved plans and addendum. Major methodology documentation utilized in the approved plans and addendum include:

- USEPA, Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual, USEPA, Region IV Environmental Services Division, Athens, GA, 1991.

- U.S. Army Toxic and Hazardous Material Agency, Geotechnical Requirements for Drilling Monitoring Wells, Data Acquisition, and Reports, March 1987.

- USAEC, U.S. Army Environmental Center Guidelines for Implementation of ER 1110-1-263 for USAEC Projects, May 1993.

3.1 Sampling Support Activities

Sampling support activities include the establishment of an onsite field office (as necessary) and supporting decontamination and material storage areas; installation of a decontamination pad and deionized organic-free water unit; and containerization and disposal of IDW.

3.1.1 Onsite Field Office and Support Areas

An on-site project meeting will be held at MLAAP prior to initiation of field activities with MLAAP, GDOS and FD personnel. MLAAP health and safety, security and emergency procedures will be discussed. A location for the placement of the field office and support area will be identified, and is anticipated to be located at the parking lot across from "C" Line. FD will mobilize to the site and set-up a field trailer and decontamination pad. Trailer set-up activities included electrical and telephone connections, and copy and fax machine delivery.

3.1.2 Decontamination Pad

A decontamination pad will be located within the support area located in the parking lot across from "C" Line, and will be installed by CBC. The decontamination pad will consist of a metal framework, lined with multiple layers of polyethylene sheeting for containment of decontamination water during equipment cleaning operations. Decontamination water accumulates within the pad until the fluids could be pumped into a holding tank for chemical analysis by the GDOS chemical laboratory and appropriate disposal in accordance with MLAAP

procedures. Decontamination activities include an initial steam cleaning of all drilling and sampling equipment along with all well casings and screens. The support area was also used for staging drums, well supplies, concrete, and other equipment associated with the field investigation.

3.1.3 Deionized Organic-free Water Unit

The decontamination pad will also contain a portable filter system to produce deionized, organic-free water at the site. This unit will be similar to deionizing systems used in a laboratory. Site water is pumped though two separate filter systems (glass beads and carbon) which removed all organic and inorganic constituents. The system filters are replaced periodically. This unit will be set-up to provide a final rinse for all decontaminated equipment and utilized for QA/QC blanks.

3.1.4 Containerization and Disposal of Investigation Derived Waste

Investigation Derived waste will be generated throughout the field program at MLAAP. Soil cuttings from drilling operations, drilling mud, development water, purge water, and miscellaneous solid wastes that are potentially hazardous will be containerized and sampled by Fluor Daniel, and analyzed for hazardous constituents by GDOS prior to disposal. Hazardous constituents will consist of nitrobodies and USEPA TAL metals. Solid wastes identified as hazardous will be disposed my GDOS in the OBG. Solid wastes identified as non-hazardous will be disposed at the plant sanitary landfill.

3.1.4.1 Soil Cuttings (Soil Borings)

Soil cuttings from drilling operations for soil borings and monitoring well installations will be visually inspected and monitored with a photoionization detector (PID) for volatile organic vapors. Cuttings will be drummed and labeled with weatherproof marking indicating the soil boring or well identification, date, location, and appropriate depth range of the contents. The drums will be sealed and transported to a secure location (or locations) where they will be stored pending results of chemical analysis. Soil samples collected for chemical analysis from soil borings will provide chemical data necessary to determine the status of drill cuttings from soil boring locations.

Following chemical analysis, any cuttings identified as hazardous waste will be transported to the plant OBG, as designated by the MLAAP Environmental Coordinator. Non-hazardous designated drill cuttings were disposed at the plant sanitary landfill.

3.1.4.2 Soil Cuttings (Monitoring Wells)

<u>Lysimeter locations within the OBG</u>:

Characterization of drill cuttings for hazardous waste determination will consist of nitrobodies, and TAL metals. A composite sample for nitrobodies and TAL metals analyses will be collected

during drilling of the lysimeter/cluster by compositing a portion of each split-barrel (split-spoon) soil sample for the lysimeter/cluster.

Monitoring Wells/Clusters locations outside the OBG and Former ADA:

Characterization of drill cuttings for hazardous waste determination will consisted of nitrobodies, and TAL metals. A composite sample for nitrobodies and TAL metals analyses will be collected during drilling of the well/cluster by compositing a portion of each split-barrel (split-spoon) soil sample for the well/cluster.

Toxicity Characteristic Leaching Procedure (TCLP): Total metal analysis of the drill cuttings will be performed with results compared against documented background levels identified at the MLAAP. TCLP will only be conducted in cases where metal levels are detected above background levels.

Following chemical analysis, any cuttings identified as hazardous waste will be transported to the plant OBG, as designated by the MLAAP Environmental Coordinator. Non-hazardous designated drill cuttings will be disposed at the plant sanitary landfill.

3.1.4.3 Monitoring Well Development/Purge Water

Monitoring well development/purge water will be containerized in a portable tank, and sampled and analyzed for nitrobodies and heavy metals. Following chemical analysis, any water identified as hazardous waste will be transported for treatment to a MLAAP carbon adsorption treatment unit designated by the MLAAP Environmental Coordinator. Non-hazardous water will be disposed into the plant sewer system, as designated by the MLAAP Environmental Coordinator.

3.1.4.4 Decontamination Water

Decontamination water will be stored in a holding tank located within the decontamination pad area. Expended decontamination water will undergo treatment for clarification using a flocculation agent, as necessary. Clarified water will be pumped out of the holding tank into a tanker truck for transport and treatment to a designated MLAAP carbon adsorption treatment unit prior to discharge. Residual sediments from holding tanks will be consolidated into drums at the conclusion of field activities and sampled for nitrobodies and TAL metals. Disposal of residual sediments will follow the same procedures as for soil cuttings.

3.2 Unexploded Ordnance Clearance

UXO site clearance operations will be conducted during the field program in areas with suspected UXO. These areas include the OBG, former ADA, and associated buffer zones. EHSI will provide qualified explosive ordnance disposal (EOD) screening personnel to clear the surface and near-surface areas used by drilling and sampling crews of UXO, in addition to conducting downhole magnetometer surveys during drilling operations to detect potential ordnance ahead of the drill bit. EHSI personnel will be present in the field during all soil boring

drilling, and lysimeter and monitoring well installations activities in these areas. EHSI standard operating procedures (SOPs) for site clearance activities are provided (Appendix A).

GDOS personnel will assist in the site clearance operations in the OBG, and former ADA with heavy earth moving equipment support, as necessary. Areas identified containing excessive scrap metal (potential UXO) detected by ESHI personnel will be scraped to depths necessary to facilitate safe field worker operations prior to subsurface sampling acquisition activities. This operation will remove the majority of scrap metal present and facilitate safe passage of drilling equipment and personnel in the areas.

3.3 Field Measurements

Field data will be collected during various sampling and monitoring activities at MLAAP. This section describes routine procedures that will be followed by personnel performing field measurements. The methods presented below ensure that field measurements are consistent and reproducible when performed by various individuals. Field personnel record field measurements on standardized logs. In addition to properly recording data on these forms, personnel maintain field notebooks in which data is recorded.

The calibration and precision requirements for field measurements are discussed in the QAPjP. The types of field measurements made at the site include:

- Water-level measurements in wells to establish vertical and horizontal hydraulic gradients during well installation, purging and prior to sampling.

- Conductivity, temperature, dissolved oxygen and pH measurements made on groundwater samples during pumping, well purging and sampling.

- Volatile organic vapor analysis of ambient air quality and soil sample headspace using a PID during field drilling activities.

3.3.1 Water-Level Measurements

Water levels will be measured using an electric probe. If a pump or other equipment are in the well, measurement devices will be lowered slowly to avoid entanglements. Water-level measurements in completed wells are made form a permanently marked reference point on the well casing. The evaluation of this point was established by survey and referenced to mean sea level. Water levels measured in boreholes or wells during construction are made relative to the ground surface. Measurements are made and recorded to the nearest hundredth of a foot. In general, water-level measurements to determine hydraulic gradients are made with an electric probe.

3.3.2 Conductivity, Temperature, Dissolved Oxygen and pH Measurements

Electrical conductivity, water temperature, dissolved oxygen and pH measurements are made in the field during purging, before each water sample collection and during well development. The

water sample is placed in a bottle or jar used solely for field testing. A field pH meter with a combination electrode or equivalent is used for pH measurements. A dissolved oxygen meter is used to measure DO. The meter is calibrated before and after each field use. The instrument automatically compensated for barometric pressure. Temperature measurements are performed using standard thermometers or equivalent temperature meters.

All instruments are calibrated as described in the QAPjP. If conductivity standard or pH buffers are used in field calibration, their values are recorded in the field notebook. The sample testing bottle and all probes are cleaned and rinsed with distilled water prior to any measurements.

3.3.3 Photoionization Detector

Volatile organic vapors present in soil samples are measured using a PID. These measurements are obtained from soil samples in the following manner:

- Instrument calibration is performed on a daily basis in accordance with manufacturer specifications;
- PID is placed immediately adjacent to soil sample for instrument reading (ppm) and then moved along length of sample to identify any variation in readings;
- Readings are recorded in field log book and geologic log; and
- Samples with readings above 100 ppm or evidence of soil disturbance/staining from disposal activities are considered for organic compound analyses.

The 100 ppm level for the PID was chosen based upon experience with UST sites throughout the country as an average level that is used to identify VOC contaminated soil. Readings less than 100 ppm may be erroneous due to varying field conditions of soil (i.e. temperature, moisture, inaccurate instrument calibration).

3.4 Soil Boring and Soil Sampling Program

The following section describes the sampling methodology recommended for the soil boring and soil sampling program. Soil borings and subsurface sample locations for each of the sites are based upon a review of best available data and previous technical efforts regarding MLAAP.

3.4.1 Soil Sampling Methodology

Standard procedures for field activities including drilling, surface and subsurface soil sampling, and decontamination are included in this section. Compliance with these procedures are designed so that representative and comparable data are collected, and samples are collected labeled, preserved and transported in a manner that preserves their integrity for their intended purposes. USAEC Geotechnical Requirements and EPA ECBSOPQAM procedures were followed during RI field activities. Details of sampling procedures are documented in the

MLAAP RI Southern Study Area (Operable Unit No. 5) Quality Assurance Project Plan (QAPjP) previously submitted and approved by TDEC and the USEPA.

3.4.1.1 Surface Soil Sampling

Surface soil samples are collected from soil borings, and selected monitoring wells located within the study area. Soil samples are collected with a stainless steel hand scoop. Twigs, leaves, pebbles, and debris that are not integral components of the soil matrix are removed by the sampling team. Samples are collected as grab or composite samples using a hand scoop. Sample are collected from 0 to 6 inches and 6 to 12 inches depth increments. Samples are thoroughly mixed prior to containerization. Samples are immediately placed in sample containers, preserved and sealed for placement in a temperature controlled (4°C) chest for shipment to the chemical laboratory.

3.4.1.2 Subsurface Soil Sampling (Drilling)

Soil samples for chemical laboratory analysis, and lithologic description are collected using a combination of hollow stem auger and mud rotary techniques. Soil borings completed as lysimeters and possibly shallow monitoring wells will be drilled using hollow stem auger techniques only. Soil samples are collected from soil borings at prescribed intervals for chemical or physical analysis.

Hollow-stem auger drilling is accomplished utilizing a hollow central shaft which is attached to a spiral scroll. Each section of auger is aligned so that a continuous scroll is formed. A bit is attached at the bottom of the first auger flight. Cutting created by the bit are removed by the scroll as the auger stem is turned. This method is suitable for relatively shallow drilling in unconsolidated formations (approximately 80 to 100 feet at MLAAP). For those boreholes used for the collection of soil samples only, the borehole is backfilled with a grout containing five percent bentonite in cement after completion. The grouted borehole is checked after 24 hours for settlement and additional grout added if necessary until the borehole is filled. At those locations which are the site of a lysimeter or monitoring well, the borehole is reamed if necessary and a lysimeter or well installed. If conditions such as heaving sands or auger refusal prevent completing a borehole (for monitoring well installations only), the auger is withdrawn and the boring is completed with a mud-rotary technique.

Mud rotary drilling can be done in unconsolidated and consolidated soils. This method allows construction of deep, large diameter wells with sufficient annular space to ensure proper placement of screen, casing, filter pack, seal, and grout column. Mud rotary drilling involves circulation of a drilling fluid, consisting of a mixture of powdered bentonite and water, down through the drill stem to cool the bit and back up the annular space of the borehole to bring cuttings to a portable mud pit at the surface. Cuttings settle out of the mud slurry to the bottom of the pit and the mud is recirculated. If thick units of fine-to medium sand are encountered the mud may have to be pumped through a desander prior to being recirculated.

The drilling mud holds the borehole open by the force of hydrostatic pressure and by the formation of a mudcake or clay lining of the borehole walls. The mudcake is formed due to

infiltration of the mud into the surrounding formation and the action of the drill bit on the borehole side walls. The drilling mud is composed of fresh water from an approved source (well T-99) and sodium bentonite type drilling mud. The quality of the drilling fluid is maintained to assure the protection of water-bearing and potential water-bearing formations in the borehole.

Soil samples are obtained using a stainless steel split-barrel (split-spoon) sampler driven into soils below the end of the leading auger flights (hollow-stem auger drilling) or bottom of hole (mud rotary drilling). While the drilling is being performed, the site hydrogeologist records the following information on the field boring log.

- Depths recorded in feet and tenth of feet.

- The estimated interval by depth for each sample taken, classified, and/or retained. For each sample, the length of sample interval and length of sample recovery was recorded. The sampler type and size (diameter and length) was recorded.

- Soil classification determined in the field at the time of sampling by the hydrogeologist, in accordance with the Unified Soil Classification System or the equivalent (ASTM D2487-83) per USAEC Geotechnical Requirements.

- A full lithologic description of each soil sample taken in accordance with USAEC Geotechnical Requirements including:

  - secondary components and estimated percentages
  - color (using a Munsell Color Chart)
  - plasticity
  - consistency (cohesive soil) or density (non-cohesive soil)
  - moisture content
  - texture/fabric/bedding, and
  - depositional environment.

- PID readings for organic vapors, and any background reading in ppm.

- A record of soil samples selected for laboratory analysis.

- A record sample was collected and labeled at each soil interval and stored at a designated location on MLAAP.

3.4.1.3 Equipment Decontamination

Decontamination procedures will follow EPA Region IV ECBSOPQAM protocols. All equipment that comes into contact with potentially contaminated soil, drilling fluid, water or other materials is decontaminated. Decontamination water (unchlorinated) is obtained from MLAAP water supply well T-99. This well was sampled prior to initiation of the field effort and analyzed for EPA TAL metals, EPA TCL VOCs and SVOCs, nitrobodies (explosive

compounds), and nitrate/nitrite. Results of analysis were provided to USAEC prior to initiation of field activities. All cleaning is performed in an area remote from surficial soil contamination.

The decontamination pad was located and constructed to accomplish decontamination procedures. The location of the pad is across from "C" Line in a paved area.

Organic-free water is also be used for decontamination purposes. The organic-free water is used for rinsing was tested and verified at the beginning of the project and re-tested periodically during field activities.

Drill rigs are decontaminated prior to the start of operations, and between soil boring, lysimeter, and well locations using approved decontamination water. Drilling equipment consisting of augers, drill rods, and other downhole equipment are decontaminated prior to the start of operations, and between soil boring and well locations as follows:

- Steam cleaning with approved decontamination water. Visible soil and grease is removed with a stiff brush.
- Brush clean with laboratory detergent and approved decontamination water.
- Rinse with approved decontamination water.
- Rinse thoroughly with deionized water.
- Rinse thoroughly with organic-free water and allow to dry.
- Wrap with aluminum foil (or plastic sheeting, if appropriate) to prevent contamination if equipment is going to be stored or transported.

3.5 Groundwater (Unsaturated Zone) Lysimeter Program

The groundwater (unsaturated zone) program for the site consists of the installation of 18 lysimeters within the unsaturated soil column of the OBG. These lysimeters will provide a means to collect water from the unsaturated zone for chemical analyses and provide data regarding the leaching of contaminants from disposal areas into the saturated groundwater flow system.

3.5.1 Groundwater (Unsaturated Zone) Lysimeter Soil Borings

3.5.1.1 Subsurface Soil Sampling (Drilling)

Soil sampling during drilling of lysimeters will be conducted in a similar manner as previously discussed for soil borings (section 3.4.1.2).

3.5.2 Groundwater (Unsaturated Zone) Lysimeter Design

Soil borings in four locations will be completed as multi-level soil water lysimeters. The lysimeters will be installed at depths of approximately 10, 20, 40, and 70 feet below ground surface. If possible, all four lysimeters at each location will be installed in a single borehole. If this is not feasible, the four lysimeters will be installed in two boreholes. All soil borings installed as part of the soil moisture lysimeter program will be installed using the hollow stem auger drilling method. The mud rotary drilling method is unnecessary since these borings will not penetrate the water table, and is undesirable since the introduction of drilling mud to the subsurface may effect the soil water samples collected.

A nominal 8-inch diameter borehole is drilled to a depth of approximately 70 feet below the ground surface. During installation of these borings, continuous soil core samples will be collected over the full boring depth, to accurately characterize subsurface geologic conditions. These data will be used to select precise vertical intervals for placement of lysimeters. Soil core samples will be collected using a 5-foot continuous core barrel, which advances continuously with the drilling augers. These vertical intervals will be selected to maximize the collection of soil water samples from immediately above any fine grained strata which may impede downward leaching of contaminated water.

After completion of the borehole and evaluation of the geologic log, the four nested lysimeters are installed at the selected depths. Each lysimeter is being installed in a silica flour slurry, according to the procedure described below. The interval between lysimeters is grouted with a mixture of 5 percent bentonite in cement. The grout is installed with a tremie pipe to ensure the proper distribution of material. The depths of lysimeter and grout intervals are verified by taping. A neat cement-bentonite seal is placed from above the 10-foot depth lysimeter to the land surface. An 8-inch diameter steel protective casing is placed for protection of the lysimeter tubes. This casing is set at least 2½ feet into the grout. The casing and grout are inspected after 24 hours and additional grout is added, as needed to fill depressions from settlement. Four 3-inch steel protective posts are installed around each set of lysimeters to prevent damage from vehicles or heavy equipment.

3.5.3 Groundwater (Unsaturated Zone) Lysimeter Installation

The procedure for lysimeter installation is summarized below:

- Tape depth of completed boring and ensure that total depth is approximately ½-foot greater than the desired depth for lowest lysimeter. If necessary, grout borehole up to desired depth, and place a 3-inch layer of bentonite pellets above grout, to the desired depth. Add one quart of deionized water, and allow to cure for ½ hour.

- Mix a thick slurry of silica flour in deionized water, and pour it into the boring to a thickness of 6 inches.

- Lower lysimeter into borehole, and insert base of lysimeter approximately 2 to 3 inches into the silica flour slurry. Secure lysimeter at ground surface to stabilize depth.

- Pour approximately 6 inches of fine sand into borehole. Confirm thickness with tape measure.

- Place approximately 6 inches of bentonite pellets into borehole, and then grout borehole to approximately ½ foot below desired depth of next lysimeter.

- Repeat the above procedure for three additional lysimeters.

- If borehole collapses or other problems prevent installation of all four lysimeters in a single borehole, drill a second borehole to the depth required to complete remaining lysimeter installations.

The lysimeter construction materials are summarized below:

- The lysimeters consist of a porous ceramic cup, which has a sufficiently small pore diameter so that water samples can be collected by applying a vacuum to the sampling cup, without withdrawing soil gases from the subsurface.

- The lysimeters are attached to a 1½-inch PVC casing which houses two ¼-inch tubes which serve as a vacuum and pressure port, respectively. These two tubes are color coded to provide identification.

- Silica flour - the silica flour material consists of pure silica sand which contains primarily silt-sized and very fine sand grains. This material is commercially available.

- The bentonite slurry, neat cement-bentonite, and protective post material specifications are identical to those described for monitoring well installations in section 3.6.4.

3.6 Groundwater Monitoring Well Program

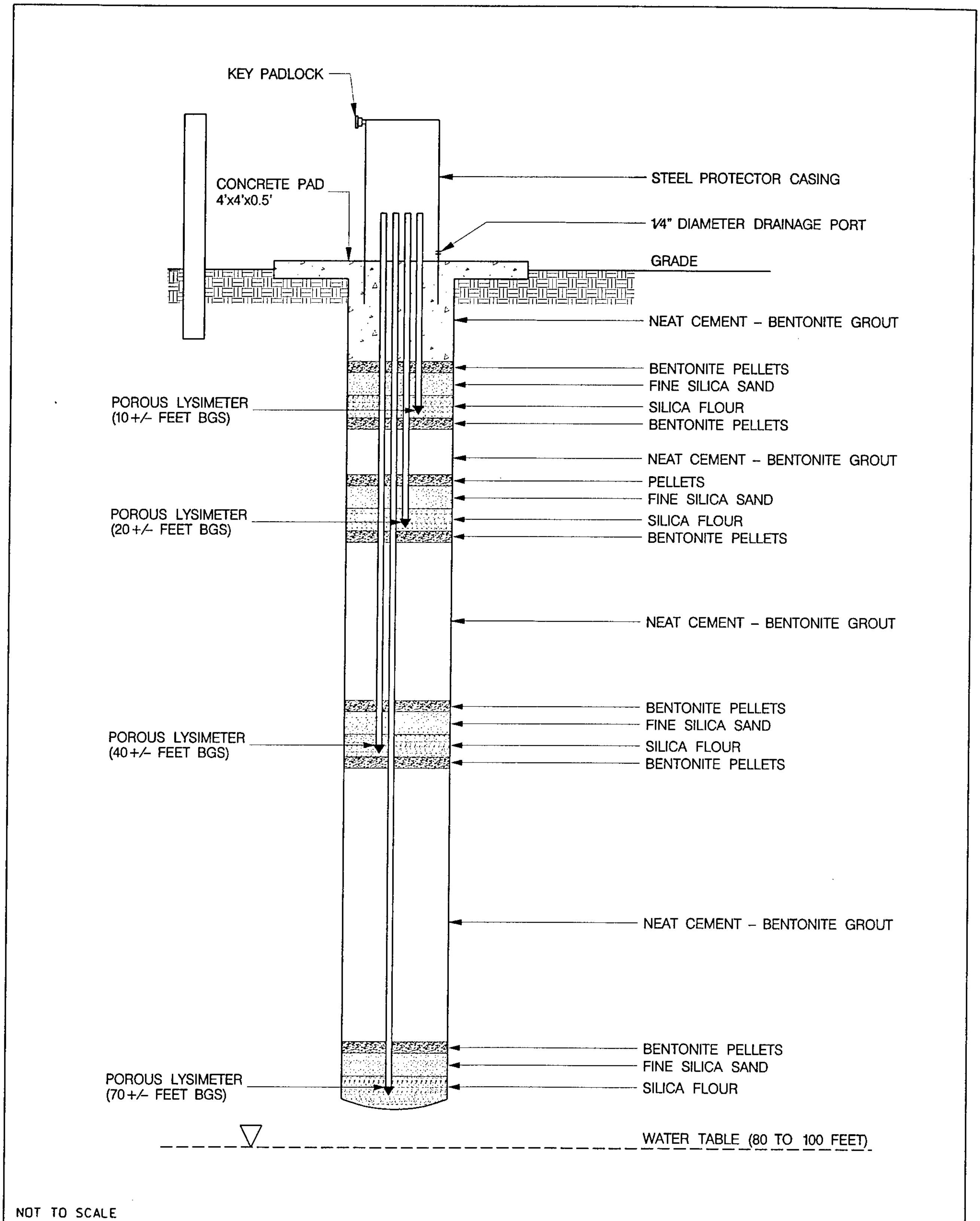
The groundwater monitoring program for the site consists of the installation of three groundwater monitoring wells. These wells complement the existing monitoring well network to determine the presence of groundwater contamination and determine the magnitude and extent of groundwater contamination emanating from the disposal areas. Existing groundwater wells installed prior to the RI effort were incorporated in the program.

3.6.1 Groundwater Monitoring Well Soil Borings

3.6.1.1 Subsurface Soil Sampling (Drilling)

Soil sampling during drilling of monitoring wells will be conducted in a similar manner as previously discussed for soil borings (section 3.4.1.2).

Figure 3-1. MLAAP RI Southern Study Area Generalized Lysimeter Construction Diagram



3.6.2 Groundwater Monitoring Well Design

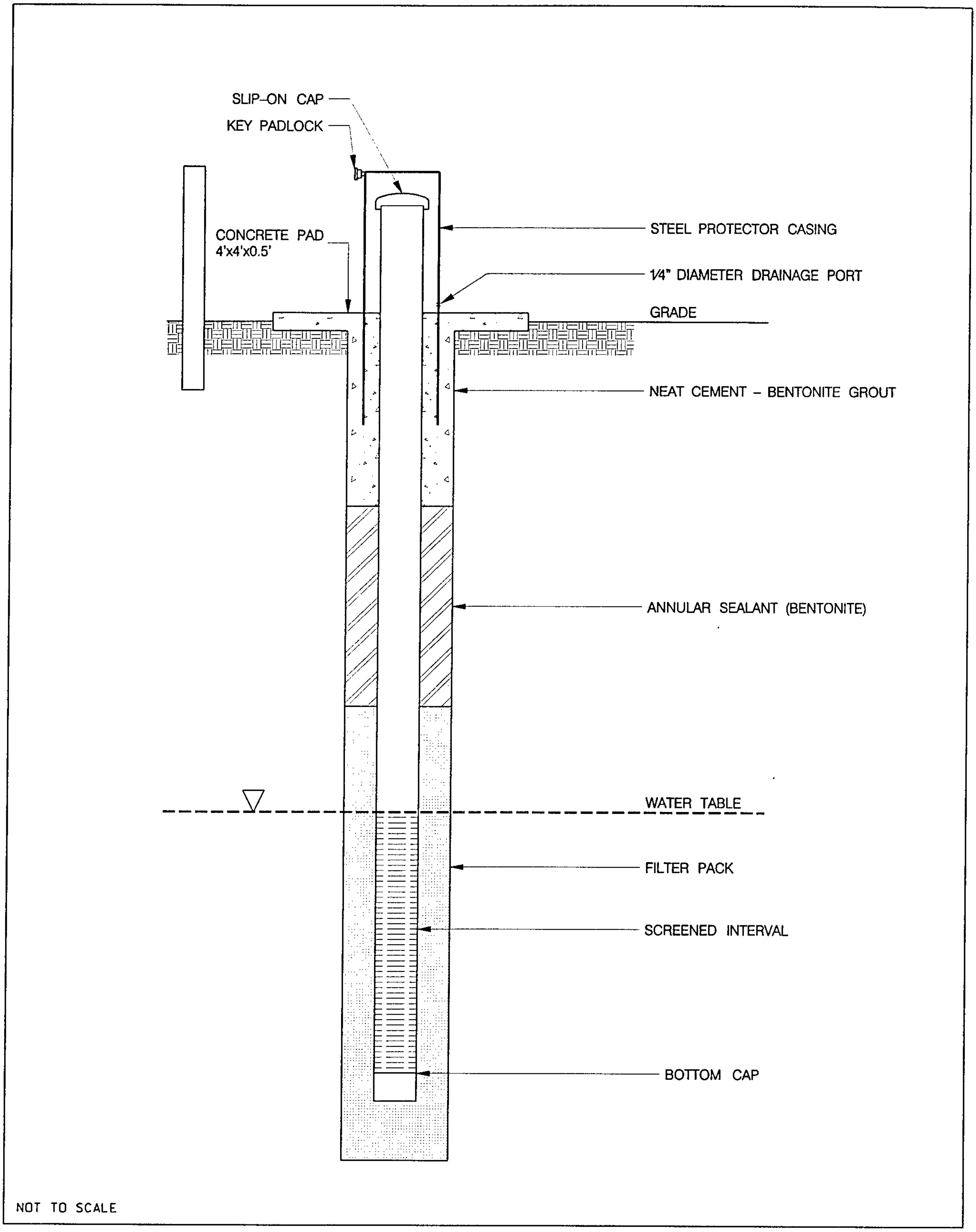
Three soil borings are planned to be completed as groundwater monitoring wells during drilling operations. Mud rotary drilling in combination with hollow stem auger drilling for monitoring well installations is planned due to the depth of groundwater (approximately 80 to 100 feet) in the MLAAP Southern Study Area. A nominal 8-inch diameter borehole is drilled to the requireddepth of individual monitoring wells. Shallow monitoring wells are screened within in the upper 10 to 20 feet of the saturated aquifer. Cluster monitoring well locations have the lowest interval monitoring well drilled and logged based upon collection of soil samples at the surface, 5 foot intervals to 20 feet, and 10 foot intervals thereafter to the bottom of the boring. Screened intervals for lower interval (middle) monitoring wells are finalized based upon results of the lowest interval well logging.

Monitoring wells are constructed of 4-in OD, flush threaded, Schedule 40, PVC casing and screen meeting NSF Standard 14wc. Screen slot size and filter pack material was determined from a review of existing MLAAP sieve analyses and other available geotechnical data. Previously installed wells utilized a 0.010 inch slot width and used 20/40 sand for the sand pack. A typical well-construction diagram is presented (Figure 3-2). Well completion depths are based on the depth to ground water and the saturated thickness of the aquifer. Well screen lengths are 10 feet long, and placed within the shallow, middle, or deep portions of the aquifer. All casing joints are flush threaded and no solvents or cements are used on the PVC. Teflon tape may have to be used as a pipe joint filler. All pipe and screen are cleaned prior to use following required decontamination procedures. Wells are completed above grade and the well head is encased with an 8-inch steel security casing with a loose fitting locking lid. Locks for all wells are provided by MLAAP.

3.6.3 Groundwater Monitoring Well Installation

Monitoring well construction for soil borings drilled by the mud rotary method are accomplished with a full column of mud in the open boring, after the drill string has been removed. The mud may have be thinned with clean water before initiating well construction to reduce the buoyancy effects and to speed the construction process. The amount of water added to the borehole is recorded. The well is installed in the open borehole with centralizers located at 50 foot intervals along the casing, and above the bentonite seal and below the bottom of the well screen to ensure that bridging does not occur during material placement. All well casing and screen materials are decontaminated using required QAPjP procedures prior to installation. A tremmie pipe is used in the annular space between the casing and walls of the borehole to ensure proper distribution of the sandpack, bentonite seal and grout column. The filterpack (USAEC approved) is placed in the annular space from the base of the well screen to a level of approximately 2 feet above the top of the screen. A bentonite seal is placed from the top of the sand pack to within 5 feet below the top of the saturated zone for middle and deep interval monitoring wells, and from the top of the sand pack to 5 feet above the sand pack for shallow monitoring wells. Bentonite is either in the form of pellets or a slurry for middle and lower interval monitoring well installations. The bentonite slurry has a minimum density of 9.4 pounds per gallon. Bentonite pellets (3/8 to 1/2 inch pellets) are used for shallow monitoring well installation and allowed to hydrate for approximately two hours prior to neat cement-bentonite

Figure 3-2. MLAAP RI Southern Study Area
Generalized Well Construction Diagram



grout placement. Depths of sand packs and bentonite seals are verified by taping. A neat cement-bentonite grout is placed from the top of the bentonite seal to the land surface. An 8-inch diameter steel protective casing is placed for well protection. The steel casing is set at least 2-½ feet into the grout. The steel casing and grout is inspected after 24 hours and additional grout added to fill depressions from settlement. Four 3-inch steel protective posts are installed around each monitoring well to prevent damage from vehicles or heavy equipment.

Monitoring well construction materials are summarized below:

- Casings and Screens - Flush threaded 4-inch Schedule 40 PVC casings and screens. Screens are factory slotted with a slot width of 0.010 inches. A loose fitting cap is placed on top of the well riser for locations not subject to flooding. Expansion seal caps are used where flooding may occur.
- Neat Cement-Bentonite Grout - Grout composed of 20 parts Portland Cement(Type II) to 1 part bentonite by weight, using 8 gallons of approved water per 94 pounds of Portland Cement. Bentonite is added following mixing of cement and water. A sample of bentonite is submitted to USAEC for approval prior to the start of the field effort.

- Bentonite Slurry - Commercially available powdered bentonite mixed with water to obtain a minimum density of 9.4 pounds per gallon.

- Filter Pack Material - Sand pack compatible with screen slot size and aquifer materials. Documentation collected on sand pack material consist of composition, grain-size distribution, cleaning procedures, and chemical analysis. A sample of filter material is provided to USAEC and approved prior to the start of the field effort.

- Monitoring Well Protection - An 8-inch steel casing is placed over the top of the monitoring well riser. The steel casing extends approximately 2-½ feet above land surface and is set 2-½ feet into the grout seal. The steel casing is vented with a loose fitting steel locking cap. Locks are provided by MLAAP. An internal mortar collar is placed within the steel casing annulus from the top of the neat cement-bentonite grout to ½ foot above the grout. A ¼ inch diameter drainage port is installed ⅛-inch above the internal mortar collar.

- Concrete Pad - A concrete pad is installed around each monitoring well. The pad measures 4-feet by 4-feet by ½-feet thick and slopes downward from the steel casing to promote drainage.

- Protective Posts - Four 3-inch protective posts are installed around each monitoring well. The posts are located within 4-feet of the well (within the concrete pad) and extend 4-feet above ground surface and 4-feet below ground surface. The protective posts and steel casings are painted orange with a brush. The well ID is painted on the side of the steel casing with white paint.

3.6.4 Groundwater Monitoring Well Development

Well development is performed to remove fine-grained material from the well screen, filter pack, and formation near the well, and to evacuate any fluid introduced downhole during drilling or well construction such as drilling mud and fresh water. By removing fine-grained material the porosity and permeability of the nearby formation increases, the filter pack is stabilized, and a hydraulic connection between the well and the aquifer is assured.

Well development is initiated at least 48 hours and not longer than 7 days after the grout is poured about the well. Well development data is recorded. A bailer or pump is used to develop the well. Water and sediment are evacuated from the well during development and a swab or the bailer used to agitate the water column within the screened interval. The agitation displaces fine material within the well screen and filter pack and allows the material to be removed by additional bailing. A minimum of five well volumes of water is removed during development. A volume includes the water standing in the well casing and the saturated annular filter pack. In general, for every volume of water added five volumes needs to be removed. Well volume is calculated using the formulas (as dictated by standing water height):

$$V=\pi h[r_c^2+n(r_w^2-r_c^2)];h<h_s$$

$$V=\pi h_s[r_c^2+n(r_w^2-r_c^2)]+\pi(h-h_s)[r_c^2];h>h_s$$

where V	-	volume of standing water in well, ft^3
π	-	3.14
r_w	-	radius of borehole, ft
r_c	-	radius of well casing, ft.
n	-	porosity of the sand (filter) pack, decimal fraction
h	-	height of standing water in well, ft.
h_s	-	height of sand (filter) pack in well, ft.

The variable h is determined by subtracting the depth to water from the top of the well casing from the total well depth. The value n assumed a value of 0.3 for this investigation. To convert the well volume in cubic ft (ft^3) to gallons, V was multiplied by 7.48. Water levels and well depths are measured with an electric sounding device. Before development, and at regular intervals during development, measurements of specific conductance, temperature, dissolved oxygen and pH are made. Wells are developed until the water produced is clean to the unaided eye, the water quality parameters have stabilized or five volumes have been removed (Table 3-8). Additional well development, if required, is conducted under the approval of the USAEC project geologist using techniques that are appropriate for the existing field conditions. Candidate development procedures included:

- Pumping,
- Compressed air (with appropriate organic filters),
- Bailing,
- Surging,
- Backwashing ("rawhiding"), or
- Jetting.

Additional development techniques (if required), are identified on an as needed basis decided in the field by the Fluor Daniel and USAEC geologists, with final approval by the USAEC geologist. Equipment used for well development are cleaned as specified in the ECBSOPQAM.

3.6.5 Topographical Survey of Soil Borings, Lysimeters, and Monitoring Wells

Newly installed soil borings, lysimeters, and groundwater monitoring wells are surveyed by a professional land surveyor using State Planar surface coordinates (to an accuracy of ± 3 feet) (Table 3-9). Vertical coordinates of the top of the PVC well casing are determined using the National Geodetic Vertical Datum of 1929 (to an accuracy of ± 0.05 feet). A permanent reference point is marked on each well casing marking the measured vertical coordinates. Groundwater level measurements are referenced from these marked reference points.

3.7 Groundwater Sampling Program

The groundwater sampling program consists of the sampling of water within both the unsaturated zone from lysimeters, and water within the saturated zone from monitoring wells and private residential wells.

3.7.1 Groundwater (Unsaturated Zone) Sampling Methodology

The lysimeters operate on the principle that water within the unsaturated zone can be drawn through the porous ceramic cup of the lysimeters by applying a vacuum to the interior of the lysimeter. The sampling procedure essentially involves two steps: 1) placing a vacuum on the appropriate vacuum port of the lysimeter, and 2) after water is drawn into the sampler purging the sample into a sample container of the ground surface by placing pressure on the appropriate part of the lysimeter. The sampling procedure is outlined below:

- Close the valve on the discharge tube and place a ⅔ atm. vacuum on the vacuum port tube of the lysimeter using the hand pump.

- Close the valve on the vacuum tube, and allow the lysimeter to draw water into the sampling cup.

- Wait approximately 6 to 12 hours, then check the residual vacuum on the vacuum port, and purge the sample contained within the lysimeter. Purging is accomplished by opening both the vacuum and discharge tubes, and using the hand pump to apply pressure

to the vacuum port of the lysimeter. This will cause the water sample to be driven upwards out of the discharge tube.

• Collect and preserve the sample volume collected (typically 250 to 300 milliliters), and then repeat the above steps to collect the total required sample volume.

3.7.2 Groundwater (Saturated Zone) Sampling Methodology

Groundwater sampling for chemical analysis is conducted no sooner than 14 days after well development has been completed. Information collected during sampling is recorded on a Water Quality Sampling form. All sampling equipment is decontaminated in accordance with QAPjP procedures before its use in each monitoring well.

Plastic sheeting is placed on the ground surrounding the well to prevent contamination of downhole equipment. The water-level and total depth of the well are measured using an electric sounding device, and the height of well casing above ground surface is measured.

The volume of water standing in the well and the saturated annulars are calculated (Section 3.6.5). At least five volumes of water are evacuated from the well using a pump to ensure that formation water is being sampled. Wells are purged until the discharge was clean, colorless, free of particulates and stable in pH, specific conductance, and temperature. Additional water volumes (beyound 5 volumes) can be evacuated, as practicable, to obtain a clear discharge and stable water quality parameters. The Fluor Daniel field geologist will contact the USAEC geologist to determine the extent of additional water evcuation (as necessary). Water is evacuated starting at the top of the water column so that all standing water is removed. If a well becomes dry before five volumes are removed, the following procedure is implemented. If the well recharges to 90% within one hour, the five volumes are removed. If recharge is less than 90%, purge a second time and sample as soon as sufficient volume recharges.

Water quality parameters including pH, temperature and specific conductance are measured periodically during the evacuation. Samples are obtained using a bottom filling Teflon bailer or from a sample port on the pump. Prior to sample collection, bottles are rinsed 3 times with formation water. Samples collected for metals analysis are not filtered. Samples are immediately placed in sample containers, preserved and sealed for placement in a temperature controlled (4°C) chest for shipment to the chemical laboratory.

3.8 Subsurface Physical Soil Testing

Split spoon soil sampling for physical soil analysis are conducted at specified intervals for soil borings drilled during the field investigation to verify field lithologic descriptions determined by the field geologist. Approximately 5% of the soil samples collected are chosen by the field geologist to verify the geotechnical parameters representative of the lithologies encountered during the drilling program. Samples are analyzed for moisture content, grain-size distribution, and Atterberg limits. USCS classifications are also assigned by the laboratory based upon results of physical analyses.

3.9 Surface Soil Sampling

3.9.1 Soil Sampling Methodology

Surface soil samples are collected with a stainless steel hand scoop. Twigs, leaves, pebbles, and debris that are not integral components of the soil matrix are removed by the sampling team. Samples are collected as grab or composite samples using a hand scoop. Sample depth intervals include 0 to 6 inches and 6 to 12 inches. Samples are thoroughly mixed prior to containerization. Samples are immediately placed in sample containers, preserved and sealed for placement in a temperature controlled (4°C) chest for shipment to the chemical laboratory.

3.10 Surface Water and Sediment Sampling

3.10.1 Surface Water and Sediment Sampling Methodology

Samples are collected from drainage ditches and intermittent tributaries that drain potential contaminant sources. Surface water samples are collected in sample bottles rinsed 3 times with the water present, if volumes allow. Sample bottle will be completely filled with surface water, as practicable, and sealed. Samples are immediately placed in sample containers, preserved (Section 4.1, Sample Preservation) and sealed for placement in a temperature controlled (4°C) chest for shipment to the chemical laboratory.

Sediment samples are collected with a stainless steel hand scoop. Prior to sampling, the hand scoop is rinsed with stream water (if present) at a point downstream from the sampling location. Sampling is accomplished upstream of any disturbances caused by the sampler or sampling team. Twigs, leaves, pebbles, and debris that are not integral components of the matrix are removed by the sampling team. Samples are collected as grab samples from the hand scoop. Sample depths do not exceed an estimated 6 inches (estimated depth of loose sediment). Samples are also thoroughly mixed prior to containerization. Samples are immediately placed in sample containers, preserved (Section 4.1, Sample Preservation) and sealed for placement in a temperature controlled (4°C) chest for shipment to the chemical laboratory.

3.11 Groundwater Depth Measurements

Groundwater depth measurements are collected from monitoring wells located throughout the OBG and adjacent down-gradient areas to quantify the groundwater flow gradients of the Memphis Sand. Geotechnical data from wells are reviewed to verify well coordinates (lateral and elevation), well construction, and screen placement prior to development of groundwater table contour mapping. Regional groundwater table maps of the Memphis Sand aquifer for the OBG are developed in addition to piezometric surfaces for the shallow, middle and deep portions of the aquifer.

4.0 ENVIRONMENTAL SAMPLING PROGRAM

Environmental samples will consist of the following matrices: soil, sediment, surface water, and groundwater. These samples will be submitted to the subcontractor chemical analytical laboratory (QST) for analyses with results entered into the IRDMIS data base following completion of data validation and QA/QC procedures. In addition, a minimun of five percent (5%) of the soil samples collected from soil borings will be submitted to a geotechnical laboratory for physical analysis (Atterberg limits and Sieve analysis). Sample location rationale and sampling procedures have been presented in previous sections of this document. Tabulations of sample locations, depths, and chemical analytes are presented (Tables 4-1 through 4-6). Complete sampling procedures, sampling labeling, and other procedures are documented i nthe QAPjP.

4.1 Sample Preservation

Environmental and field QC sample container types, preservation, and holding time requirements are present (Table 4-7). Preservation of samples in the field will occur immediately following sample collection. Sample pH adjustment will be performed using disposable polyethylene droppers, with pH measurements using disposable paper strips. Samples will be iced and cooled to 4°C.

4.2 Sample Chain-of-Custody (COC) and Shipment

Chain-of-custody forms and sample traffic reports will be completed and will accompany each sample. Data on the forms will include the boring number, depth interval, date sampled, project name, project number, and signatures of those in possession of the sample. The forms will accompany the samples shipped to the designated laboratory so that sample possession information can be maintained. The field team will retain a separate copy of the chain-of-custody and traffic reports at the field office.

All samples will be shipped daily by overnight air freight to the laboratory. Samples will be treated as environmental samples (unless a determination is made in the field that samples should be shipped as DOT hazardous samples), shipped in heavy duty coolers, packed in vermiculite, and preserved with ice in sealed plastic bags. Fluor Daniel will place custody seals on all sample bottles and coolers. Each shipment will include the appropriate field QC samples (i.e., trip blanks, duplicates, preservation blanks, and rinsate blanks). Corresponding chain-of custody forms and sample traffic reports will be placed in waterproof bags and taped to the inside of the cooler lids.

4.3 Sample Storage

Samples awaiting analysis will be stored in a secure, temperature-controlled cold room at the designated laboratory. At the completion of analyses, any remaining sample volume will be labeled and stored in the cold room, pending final disposition. Sample disposal will take place only after verification of receipt of fully validated data by the USAEC IRDMIS and documented approval by the USAEC Project Officer.

4.4 Quality Assurance Samples

Duplicate samples will be collected at a frequency of approximately 5 percent for solid samples and 10 percent for aqueous samples. The results from duplicated samples will be used to spot-check laboratory precision. Other indicators of precision are the daily analyses of laboratory matrix spike samples.

Rinse blanks will be collected at a frequency of approximately 5 percent of total sampling equipment and downhole drilling equipment cleaned (minimum of one per week for each). The purpose of rinse blanks is to determine if decontamination procedures have been sufficient to prevent cross-contamination between samples. Rinse blanks are collected by pouring deionized organic-free water over the decontaminated sampling equipment. The rinse water is collected in aqueous sample bottles and analyzed for the same parameters for which the corresponding environmental sample is analyzed.

Preservative blanks will be prepared to determine if the preservatives used during field operations were contaminated. The samples will be prepared by putting analyte-free/organic-free water in the sample container and then preserving the sample with the appropriate preservatives. Two (2) preservative blanks will be collected for chemical analyses.

Samples will also be collected of decontamination water, drilling water, bentonite, grout, and sand, as specified in the ECBSOPQAM.

Table 4-1. MLAAP RI Southern Study Area
Surficial Soil Samples Summary

Contaminant Source Area	Site Type	Site ID	Total Depth (ft) (estimate)	Chemical Categories			
				Nitrobodies	Cd	Cr (total)	Pb
Open Burning Ground							
Outside Disposal Area "B"	GRAB	B001	0 to 6 inches (D) 6 to 12 inches (D)	• •	• •	• •	• •
	GRAB	B002	0 to 6 inches 6 to 12 inches	• •	• •	• •	• •
	GRAB	B003	0 to 6 inches 6 to 12 inches	• •	• •	• •	• •
	GRAB	B004	0 to 6 inches 6 to 12 inches	• •	• •	• •	• •
	GRAB	B005	0 to 6 inches 6 to 12 inches	• •	• •	• •	• •
	GRAB	B006	0 to 6 inches 6 to 12 inches	• •	• •	• •	• •
	GRAB	B007	0 to 6 inches 6 to 12 inches	• •	• •	• •	• •
	GRAB	B008	0 to 6 inches 6 to 12 inches	• •	• •	• •	• •
Disposal Area "A"	GRAB	A001	0 to 6 inches 6 to 12 inches	• •	• •	• •	• •
Disposal Area "B"	GRAB	B009	0 to 6 inches 6 to 12 inches	• •	• •	• •	• •
Disposal Area "D"	GRAB	D001	0 to 6 inches 6 to 12 inches	• •	• •	• •	• •
Disposal Area "F"	GRAB	F001	0 to 6 inches 6 to 12 inches	• •	• •	• •	• •
Disposal Area "SH"	GRAB	SH001	0 to 6 inches 6 to 12 inches	• •	• •	• •	• •
Totals				28 (1)	28 (1)	28 (1)	28 (1)

(1) The "(D)" indicates that a QC field duplicate was collected in addition to the normal soil sample for the given depth and interval.

(2) "Totals" include QC field duplicates.

Table 4-2. MLAAP RI Southern Study Area
Soil Boring Soil Samples

Contaminant Source Area	Site Type	Site ID	Soil Boring Depth	Sample Depth (feet)	Sample Interval (feet)	Chemical Categories			
						Nitrobodies	Cd	Cr (total)	Pb
Open Burning Ground									
Outside Disposal Area "B"	Bore	W029	70 feet	10	0.5	•	•	•	•
				20	0.5	•	•	•	•
				40	0.5	•	•	•	•
				70	0.5	•	•	•	•
Disposal Area "A"	Bore	W030	70 feet	10 (D)	0.5	•	•	•	•
				20	0.5	•	•	•	•
				40	0.5	•	•	•	•
				70	0.5	•	•	•	•
Disposal Area "B"	Bore	W031	70 feet	10	0.5	•	•	•	•
				20	0.5	•	•	•	•
				40 (D)	0.5	•	•	•	•
				70	0.5	•	•	•	•
Disposal Area "D"	Bore	W032	70 feet	10	0.5	•	•	•	•
				20	0.5	•	•	•	•
				40	0.5	•	•	•	•
				70	0.5	•	•	•	•
Disposal Area "F"	Bore	W033	70 feet	10	0.5	•	•	•	•
				20	0.5	•	•	•	•
				40	0.5	•	•	•	•
				70	0.5	•	•	•	•
Ditch 9	Bore	W034	70 feet	10	0.5	•	•	•	•
				20	0.5	•	•	•	•
				40	0.5	•	•	•	•
				70	0.5	•	•	•	•
Totals						26 (1)	26 (1)	26 (1)	26 (1)

(1) The "(D)" indicates that a QC field duplicate was collected in addition to the normal soil sample for the given depth and interval.

(2) "Totals" include QC field duplicates.

Table 4-3. MLAAP RI Southern Study Area
Lysimeter Groundwater Samples

Contaminant Source Area	Site Type	Site ID	Aquifer Depth	Total Depth (ft)	No. of Samples	Chemical Categories			
						Nitrobodies	Cd	Cr (total)	Pb
Open Burning Ground									
Outside Disposal Area "B"	LYSM	LY001	Unsaturated Zone	20.0	1	•	•	•	•
Disposal Area "A"	LYSM	LY002	Unsaturated Zone	10.0	1	•	•	•	•
		LY003		20.0	1	•	•	•	•
		LY004		40.0	1	•	•	•	•
		LY005		70.0	1	•	•	•	•
Disposal Area "B"	LYSM	LY006	Unsaturated Zone	20.0	1 (D)	•	•	•	•
Disposal Area "D"	LYSM	LY007	Unsaturated Zone	10.0	1	•	•	•	•
		LY008		20.0	1	•	•	•	•
		LY009		40.0	1	•	•	•	•
		LY010		70.0	1	•	•	•	•
Disposal Area "F"	LYSM	LY011	Unsaturated Zone	10.0	1	•	•	•	•
		LY012		20.0	1	•	•	•	•
		LY013		40.0	1	•	•	•	•
		LY014		70.0	1	•	•	•	•
Ditch 9	LYSM	LY015	Unsaturated Zone	10.0	1	•	•	•	•
		LY016		20.0	1	•	•	•	•
		LY017		40.0	1	•	•	•	•
		LY018		70.0	1	•	•	•	•
Totals					19	19	19	19	19

(1) The "(D)" indicates that a QC field duplicate was collected in addition to the normal soil sample for the given depth and interval.

(2) "Totals" include QC field duplicates.

Table 4-4. MLAAP RI Southern Study Area
Monitoring/Residential Well Groundwater Samples

Contaminant Source Area	Site Type	Site ID	Aquifer Depth	Total Depth (ft)	No. of Samples	Chemical Categories			
						Nitrobodies	Cd	Cr (total)	Pb
Open Burning Ground									
Background inside Ditch 9	WELL	MI412	Shallow	100.0	1	•	•	•	•
Former Ammunition Destruction Area									
Disposal Area "C"	WELL	MI413	Shallow	140.0	1	•	•	•	•
		MI414	Middle	210.0	1	•	•	•	•
Totals					3	3	3	3	3

(1) The "(D)" indicates that a QC field duplicate was collected in addition to the normal soil sample for the given depth and interval.

(2) "Totals" include QC field duplicates.

Table 4-5. MLAAP RI Southern Study Area
Surface Water Samples

Site Type	Site ID	Sample Matrix	No. of Samples	Chemical Categories			
				Nitrobodies	Cd	Cr (total)	Pb
Open Burning Ground							
Crek	33SW01	Surface Water	1	•	•	•	•
Crek	33SW02	Surface Water	1	•	•	•	•
		Totals	2	2	2	2	2

Table 4-6. MLAAP RI Southern Study Area
Sediment Samples

Site Type	Site ID	Sample Matrix	No. of Samples	Chemical Categories			
				Nitrobodies	Cd	Cr (total)	Pb
Open Burning Ground							
Crek	33SW01	Sediment	1	•	•	•	•
Crek	33SW02	Sediment	1	•	•	•	•
		Totals	2	2	2	2	2

Table 4-7. MLAAP RI Southern Study Area
Environmental and Field Quality Control Sample Container, Preservation, and Analytical Holding Time Requirements

Chemical Category	Environmental Matrices	Container and Preservation	Analytical Holding Time
TAL Metals	Surface water Groundwater	1 - liter polyethylene bottle. Nitric acid (HNO_3) added to obtain a pH < 2 (50% NaOH). Cooled to 4°C.	180 days. 28 days for Hg.
TAL Metals	Soil Sediment	Sample tube (capped) or 1 - 8 ounce glass bottle with Teflon lined enclosure. Cooled to 4°C.	180 days. 28 days for Hg.
Nitrobodies	Surface Water Groundwater	2 - 1 liter amber glass bottles with Teflon lined enclosure. Cooled to 4°C.	7 days to extraction. Analysis within 40 days of extraction preparation.
Nitrobodies	Soil Sediment	Sample tube (capped) or 1 - 8 ounce amber glass bottle with Teflon lined enclosure. Cooled to 4°C.	14 days to extraction. Analysis within 40 days of extraction preparation.

5.0 CHEMICAL LABORATORY ANALYTICAL PROGRAM

5.1 Chemical Laboratory Certification

USAEC chemical laboratory validation will be required for chemical analysis of environmental samples for the MLAAP RI of the Southern Study Area. QST, the chemical laboratory subcontractor, has obtained validation in accordance with the USAEC Guidelines for Implementation of ER 1110-1-263 for USAEC Projects prior to the initiation of any field sampling conducted at MLAAP. Details of laboratory validation procedures are provided in the USAEC Guidelines for Implementation of ER 1110-1-263 for USAEC Projects. Proposed methods that will require validation are proved (Table 5-1). QST is a U.S. Army Corps of Engineers - Missouri River Division (MRD) validated laboratory for all required chemical analyses under the RI. QST will determine Method Detection Levels (MDLs) for all required analytes in accordance with the USAEC Guidelines for Implementation of ER 1110-1-263 for USAEC Projects, Section 5.0 Laboratory Validation. Target MDLs (Required Detection Levels (RDLs)) are provided for all analytes (Table 5-1). Chemical analytical methods were selected from EPA Solid Waste (SW)-846 Methods (Table 5-1). MDL validation will be completed and approved by the USAEC prior to initiation of the field effort.

5.2 Non-certified Methods

Nitrobodies (explosives) analyses are required for soil analyses. This method is not certified under the USAEC Guidelines for Implementation of ER 1110-1-263 for USAEC Projects. EPA SW-846 Method 8330 modified for soil will be used for soil analysis.

Table 5-1. MLAAP RI Southern Study Area
Target Analyte List Methods

USCOE Method No.	EPA Method No.	Method	Test Name	Analyte	CAS Number	MDL (μg/l)
SS18	6010	Metals/Water/ICAP	CD	Cadmium	7440-43-9	3.01
SS18	6010	Metals/Water/ICAP	CR	Chromium	7440-47-3	6.95
SS18	6010	Metals/Water/ICAP	PB	Lead	7439-92-1	50.00
JD20	7421	Metals/Water/GFAA	PB	Lead	7439-92-1	1.26

Table 5-1. MLAAP RI Southern Study Area
Target Analyte List Methods

USCOE Method No.	EPA Method No.	Method	Test Name	Analyte	CAS Number	MDL (μg/g)
JS16	6010	Metals/Soil/ICAP	CD	Cadmium	7440-43-9	0.7
JS16	6010	Metals/Soil/ICAP	CR	Chromium	7440-47-3	4.05
JS16	6010	Metals/Soil/ICAP	PB	Lead	7439-92-1	10.57
JD17	7421	Metals/Soil/GFAA	PB	Lead	7439-92-1	.0.177

Table 5-2. MLAAP RI Southern Study Area
Nitrobodies (Explosive Compounds) Methods

USCOE Method No.	EPA Method No.	Method	Test Name	Analyte	CAS Number	MDL (µg/l)
UW32	8330	Explosives/Water/HPLC	135TNB	1,3,5-Trinitrobenzene	99-35-4	0.449
UW32	8330	Explosives/Water/HPLC	13DNB	1,3-Dinitrobenzene	99-65-0	0.611
UW32	8330	Explosives/Water/HPLC	246TNT	2,4,6-Trinitrotoluene	118-96-7	0.635
UW32	8330	Explosives/Water/HPLC	24DNT	2,4-Dinitrotoluene	121-14-2	0.0637
UW32	8330	Explosives/Water/HPLC	26DNT	2,6-Dinitrotoluene	606-20-2	0.0738
UW32	8330	Explosives/Water/HPLC	2A46DT	2-Amino-4,6-dinitrotoluene		0.157
UW32	8330	Explosives/Water/HPLC	4A26DT	4-Amino-2,6-dinitrotoluene		1.57
UW32	8330	Explosives/Water/HPLC	2NT	2-Nitrotoluene	88-77-2	0.406
UW32	8330	Explosives/Water/HPLC	3NT	3-Nitrotoluene	99-08-1	1.4
UW32	8330	Explosives/Water/HPLC	4NT	4-Nitrotoluene	99-99-0	1.11
UW32	8330	Explosives/Water/HPLC	HMX	Cyclotetramethylenetetranitramine	2691-41-0	1.21
UW32	8330	Explosives/Water/HPLC	NB	Nitrobenzene	98-95-3	0.645
UW32	8330	Explosives/Water/HPLC	RDX	Cyclotrimethylenetrinitramine	121-82-4	1.17
UW32	8330	Explosives/Water/HPLC	TETRYL	N-methyl-N,2,4,6-tetranitroaniline	479-45-8	.5

Table 5-2. MLAAP RI Southern Study Area
Nitrobodies (Explosive Compounds) Methods

USCOE Method No.	EPA Method No.	Method	Test Name	Analyte	CAS Number	MDL ($\mu g/g$)
8330	8330	Explosives/Soil/HPLC	135TNB	1,3,5-Trinitrobenzene	99-35-4	.1
8330	8330	Explosives/Soil/HPLC	13DNB	1,3-Dinitrobenzene	99-65-0	.1
8330	8330	Explosives/Soil/HPLC	246TNT	2,4,6-Trinitrotoluene	118-96-7	.1
8330	8330	Explosives/Soil/HPLC	24DNT	2,4-Dinitrotoluene	121-14-2	.1
8330	8330	Explosives/Soil/HPLC	26DNT	2,6-Dinitrotoluene	606-20-2	.1
8330	8330	Explosives/Soil/HPLC	2A46DT	2-Amino-4,6-dinitrotoluene		.1
8330	8330	Explosives/Soil/HPLC	4A26DT	4-Amino-2,6-dinitrotoluene		.1
8330	8330	Explosives/Soil/HPLC	HMX	Cyclotetramethylenetetranitramine	2691-41-0	.2
8330	8330	Explosives/Soil/HPLC	NB	Nitrobenzene	98-95-3	.1
8330	8330	Explosives/Soil/HPLC	RDX	Cyclotrimethylenetrinitramine	121-82-4	.2
8330	8330	Explosives/Soil/HPLC	TETRYL	N-methyl-N,2,4,6-tetranitroaniline	479-45-8	.5

6.0 DATA MANAGEMENT

Data management is discussed in the Data Management Plan that details the procedures that will be used for the MLAAP RI of the Southern Study Area. Entries for environmental samples will be in accordance with the IRDMIS User's Guide, Volumes I and II (1993). Site Types and Site Identifications have been assigned for environmental samples throughout the Field Sampling Plan and will be used during data entry into the IRDMIS database.

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APPENDIX A

MLAAP RI Southern Study Area
UXO Site Clearance
General Standard Operating Procedures

ENVIRONMENTAL HAZARDS SPECIALISTS
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Belvidere, North Carolina 27919
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General SOP

Site/Pit Excavation and Scrapings

Site/pit excavations and scrapings at the Milan Army Ammunition Plant will be conducted using standard Explosives Ordnance Detachment (EOD) procedures and safety precautions. Many of the sites have possibly had explosive, chemical, or incendiary ordnance detonated, burned or buried throughout the many years of operations. The general approach for preparing and excavating a site for collecting survey data required will be as follows:

A. Site Perimeter Determination and Surface Sweep Procedures.

1. Using marking stakes and lines as necessary, mark the outer perimeter of each site to be surveyed. An additional 25 feet may be added to the perimeter to ensure complete coverage.
2. Clear the area of miscellaneous surface scrap metal and/or ordnance items.
3. Conduct a geophysical survey of the entire area. Record and mark areas which have the highest concentrations of magnetic and metallic anomalies.
4. Using marking stakes and lines as necessary, mark the outer perimeter of the suspected burial areas.

B. Site/Pit Excavation Procedures

5. Plan to mark out a path for a trench to be dug out through the middle of the burial site. The trench will be with width of the back hoe and will continue down until the bottom of the burial site is determined.
6. Initial excavation will be conducted by hand or by using hand tools to carefully remove the dirt surrounding the suspected UXO until positive identification

can be made. If deemed necessary, remote handling equipment may be required.

7. Once located, carefully identify the exposed UXO to determine safety factors to be considered for removal.
8. Remove all unnecessary personnel from the area.
9. If removal is possible slowly lift the UXO from the excavation and place it on the surface next to the trench. Necessary steps will then be taken to move the UXO to a safe location to await further action.
10. Follow on Excavation - Following positive identification/determination of explosive/chemical hazard of UXO removed from a pit, and upon recommendation by EHSI, excavation procedures may be modified to permit use of the back hoe for the excavation of dirt surrounding the UXO. In this instance, the following procedures will be used.
    - Position the back hoe so that the UXO to be uncovered can be approached from the side.
    - Carefully remove dirt from the side of the UXO until it is partially or nearly exposed.
    - Revert to hand tools for final excavation.

      If, during the course of the excavation/removal of UXO from the pit area, other UXO or bulk explosive/propellant/chemical materials are found, they will be removed and handled in accordance with the approved SOP.
11. The excavated material will be placed in an isolated area within the existing site. EHSI will catalog all metal found and estimate the various types and quantities found. The excavation activities will take place on a day when the winds are calm to minimize dispersion of the materials.

C. TANKS OR DRUMS

12. In the event that a high pressure cylinder, tank or drum or other excessively large container is exposed during excavation, normal activities will cease and all unnecessary personnel will retreat to at least 150 ft from the vicinity of the container.

    The safety technician will determine the appropriate action level of protection and monitor the breathing zone near the container with the proper instrument. (TIP/HNU/OVA). If possible the container will be identified, sampled, packaged, deconned, and overpacked. EHSI will recommend to USAEC and MAAP whether the container contents should be screened for Army chemical agents. In the event that Chemical Surety Materiel (CSM) is encountered the USAEC project officer, and the USAEC Safety and Environmental Services Branch will coordinate CSM sampling support with the U.S. Army Technical Escort Unit and MAAP safety and surety offices. CSM is not expected to be found at MAAP.

13. Safety of personnel and equipment is foremost in the EHSI International, Inc. management and operational philosophy. Fully trained supervisory personnel are directly involved in all operations. They have the experience and responsibility to identify potentially hazardous situations. The Program Manager, Safety Officer, Field Supervisor and all EOD/HAZMAT Specialists have the authority and responsibility to immediately stop work and take corrective action when an unsafe situation is encountered. Standard EOD procedures will be employed in the investigation/handling of ordnance related items until it is determined that no explosive hazard exists.

14. Restoration

    After each burial pit has been cleared of exposed UXO and metallic debris, the area will be filled in to conform with the surrounding terrain.

Test Trenches

The following are procedures to be followed during excavation and back filling of the test trenches or test pits.

- All personnel involved in these activities shall wear the appropriate level of protective equipment upon entering the exclusion zone of each trench area if intrusive activities are being conducted.
- If required, approach the test trench location with continuous air monitoring to obtain background air quality readings. Always approach from upwind if possible.
- If possible, orient the back hoe so that the back hoe operator is located upwind or that a cross wind is blowing from left to right or right to left.
- Begin excavation of the test trench/pit using shallow strokes placing the excavated material on the downwind side of the trench. All personnel will remain on the upwind side, if grab samples are required the back hoe operator will be signaled by the EHSI safety specialist who will have the bucket brought to the geologist, where a grab sample can safely be obtained for chemical analysis.
- Provide the air quality monitoring in the breathing zone of each worker. If the designated PPM level is exceeded in the breathing zone at any time, stop excavation, egress the exclusion zone, and notify the CP. The CP will notify safety officer and the site supervisor. Work will resume on the recommendations of the site H&S technician with concurrence of the site manager.
- During trenching operations sampling personnel will view the trench walls from the ends of the excavation. Field personnel shall remain in clear view of the back hoe operator at all times. No one will enter any trench that is greater than 3 feet in depth.
- In the event that suspected UXO are encountered the EHSI SOP for trenching will be followed.

- The sampling plan will be followed on obtaining samples and deconning the sample equipment (i.e. bucket, shovel). The back hoe will be decontaminated prior to field operations, the bucket between trenches, the back hoe again after field operations are complete. On extended operations the back how and front end loader will be taken through decon on fridays cleaned and PMS conducted.
- Test trenches/pits will be back filled when sampling or field activities are completed. All trenches will be staked and safety tape will be strung around the trench. The last days of the operation will be used to back fill all open trench/pits.

SOP

FOR THE CLEARANCE OF LANDFILLS

A surface visual sweep team, consisting of a minimum of two EOD trained specialists will conduct a visual search and clearance of landfill areas. Unexploded ordnance items and ordnance debris will be collected. Unexploded ordnance that can be safely moved will be placed at a designated ordnance holding area and dealt with in accordance with the Standard Operating Procedures as agreed with the Contracting Officer's Representative (COR).

Site Perimeter Determination and Surface Sweep Procedures

1. Using marking stakes and lines as necessary, mark the outer perimeter of each site to be surveyed.
   Additional footage may be added to the perimeter to ensure complete coverage.
2. Clear the area if miscellaneous surface scrap metal and/or ordnance items.
3. Conduct a geophysical survey of the entire area. If necessary, to achieve an effective geophysical survey, (i.e. surface burn area) scrape off the top 6" to 12" of the surface of the area to be surveyed. Record and mark areas which have the highest concentrations of magnetic and metallic anomalies.
4. Using marking stakes and lines as necessary, mark the outer perimeter of the suspected burial areas.

1. Geophysical Survey

The geophysical survey team will be assisted by an EOD specialist and will conduct a subsurface electromagnetic search of the landfill site. The Foerster Electromagnetic Detector (MK 26 Ordnance Locator) Schonstedt and White/Eagle will be used for the subsurface survey. The MK 26 is the most recent military approved locator and is in use by the U.S. Military EOD forces for detecting subsurface ordnance items. The locator is a handheld unit and uses 2 fluxgate magnetometers, aligned and mounted a fixed distance apart to detect

changes in the earth's ambient magnetic field caused by ferrous metal or disturbances caused by soil conditions. Both an audio and metered signal are provided to the operator. The metered signal indicates whether the disturbance is geodetic or metal-related. The detection capability of the MK 26 is dependent on the size of the item versus its depth and on the experience of the operator. In general terms, the MK 26 will easily detect a 60 mm projectile to a depth of 3 meters and a 155 mm projectile to 6 meters.

The EOD specialist will use the MK 26 and search along one side of the grid line for subsurface contamination. When a contact is found, the specialist will check with his hand to determine if the contact is on or just below the surface. If the contact is buried, the ordnance locator operator will mark the spot and continue until the fade out zone is established for each landfill.

Any excavations deemed necessary will be accomplished by hand or with hand tools and in accordance with standard EOD procedures.

An EOD technician will be present to ensure safety and to verify all excavations. The items will then be recorded on the survey grid data sheets.

a. Personal Protective Clothing and Vapor Monitoring Procedures

1. The level of protective clothing required for this operation is dependent upon the hazard analysis. The level required for scraping and excavating in areas not known or suspected of having been contaminated with army chemical agents or chemical munitions will be determined in accordance with the Contractors Health and Safety Plan. This will normally be either Level D or C, with the provision for upgrading/downgrading as necessary.

2. All trenching/excavating/soil movement in work areas will be accomplished in (Level D). Continuous monitoring with OVA/HNU will be required. Negative results will not automatically be used to justify downgrading of protective clothing. Elevated

readings on the OVA/HNU will result in the stopping of work and a decision whether to evacuate or continue work in elevated levels of protective clothing.

SOP

FOR TRENCHING OPERATIONS

The mechanized equipment used, will excavate in a precise manner at the predesignated locations, (Excavate no more than 4" of soil per sweep until contact is made with buried material). At this point, if required, hand digging will be initiated to identify the contact, and depending upon the outcome, the excavation may continue until the surface of the waste dump is explored. On identification of the nature of the waste, the appropriate SOP will be activated to take waste samples. Should the nature of the waste be highly hazardous or toxic, a remote method (can) will be used to extract the sample and place it in an appropriate designed container.

a. Site/Pit Excavation Procedures

1. Remove all necessary personnel from the area. Plan and mark out a path for a trench to be dug out through the middle of the burial site. The trench will be the width of the back hoe/bucket and will continue down until the bottom or water is reached.
2. During excavation an observer will monitor the operation closely, if suspected explosives are found operations will be halted and excavation will be conducted by hand or using hand tools to carefully remove the dirt surrounding the suspected hazards until positive identification can be made. If deemed necessary, remote handling equipment may be required.
3. Once located, carefully identify the exposed explosive material to determine safety factors to be considered for removal.
4. If identified explosives such as dynamite or nitroglycerin crystals are found, the trench location will be abandoned.
5. Follow on Excavation - following positive identification/determination of explosive/chemical hazard and upon recommendation by EHSI, excavation procedures may be modified.

- Position the equipment such that the hazard to be uncovered can be approached from the side.
- Carefully remove dirt from the side of the hazard until it is partially or nearly exposed.
- If required revert to hand tools for final excavation.

If during the course of the excavation of the hazardous material from the pit area, other bulk explosive/propellant/chemical materials are found, they will be handled in accordance with the WCC sampling plan.

6. The excavated material will be placed in an isolated area within the existing site. EHSI will catalog all explosive related material found and estimate the various types and quantities found. The excavation activities will take place on a day when the winds are calm to minimize dispersion of the materials.
7. If any drums are discovered, normal excavation activities will stop. Unnecessary personnel will retreat at least 50 feet up wind from the vicinity of the drums. OVA and/or HNU analyzers will monitor the air near the drums. If any unusual readings are exhibited, then necessary personnel will wear protective clothing appropriate for the hazard. The dirt around the drums will be removed. Personnel will carefully move the drum from the excavation pit. The drum will be overpacked. Qualified personnel will identify the contents and properly store the drum at a designated location on site or at any other appropriate location at the work site.

A. <u>Personal Protective Clothing and Vapor Monitoring Procedures</u>

1. The level of protective clothing required for this operation is dependent upon the hazard analysis. The level required for scraping and excavating in areas not known or suspected of having been contaminated with army chemical agents or chemical munitions will be determined in accordance with the Client Health and Safety Plan. This will normally be Level C with the provision for upgrading/downgrading as necessary.

2. All trenching/excavating/soil movement in work areas suspected or known to contain life threatening materials will be accomplished in (Level B). Continuous monitoring with OVA/HNU will be required. Negative results will not automatically be used to justify downgrading of protective clothing. Elevated readings on the OVA/HNU will result in the stopping of work and a decision whether to evacuate or continue work in elevated levels of protective clothing.

SOP

FOR INSTALLATION OF MONITORING WELL AND SOIL BORINGS

EHSI will be present during all field operations and will clear access to and a large enough working area and a separate location for decon if required, and any locations where activity is taking place. Many of the sites have had explosive, or incendiary ordnance detonated, burned or buried throughout the many years of operations. It should be noted that if there is dirt roads in the area do not assume they are clear as ordnance will surface from time to time. The general approach for clearing and preparing monitoring well or boring locations for collecting survey data required will be as follows:

1. Well Locations

In advance of well installation, EHSI EOD specialists will surface sweep the access to the well sites, a minimum width in the access way of 25 feet and a working area at the well site area of approximately 90 feet in diameter (this can be larger) will be cleared of any UXO as per the Standard Operating Procedures. Both ferrous and nonferrous locators will be used to assist in achieving a high effectiveness of the surface sweep.

If required mechanized equipment will be used and operated by EHSI personnel, or personnel designated by the Client, to clear scrub and any natural or manmade underground obstacles (i.e. boulders, tree roots, concrete, etc.) to enable well drilling equipment to have access and be operated at the designated site. Also an area will be cleared for a field decontamination location for use by the drillers.

Wells that are to be installed in areas where there is a potential for subsurface UXO will be surveyed on the surface and then surveyed at intervals of 2 to 4 feet to the depth of concern depending on specific UXO contaminant characteristics. Drill augers will be removed and the drill rig moved a minimum of 20 feet from the hole. The probe of the MK26 will be lowered to clear another interval. This procedure will be followed at a minimum to a depth of (20) feet or an agreed upon depth after the cuttings have been observed by the site geologist and the UXO technician.

PROTECTIVE CLOTHING AND VAPOR MONITORING PROCEDURES

1. The level of protective clothing required for the operation is dependent upon the hazard analysis. The level required for installation of borings and monitoring wells or scraping and excavating in areas not known or suspected of having been contaminated with army chemical agents or chemical munitions will be determined in accordance with the Clients Health and Safety Plan. This will normally be either level D with the provision for upgrading as necessary.
2. All monitoring well and boring clearance will be in level (D). (NOTE) All initial trenching/excavating/soil movement in work areas will be accomplished in (Level D). Continuous monitoring with OVA/HNU will be required. Negative results will not automatically be used to justify downgrading of protecting clothing.

Elevated readings on the OVA/HNU will result in the stopping of work and a decision whether to evacuate or continue work in elevated levels of protective clothing.

ADDENDUM

SURVEYING BORINGS AND MONITORING WELL LOCATIONS

1. The Environmental Hazards Specialists, Int. Inc. (EHSI) SOP, the client Health & Safety and Sampling Plans will be the guidelines for reference, the following will be the EOD procedures that will be followed to insure that the boring/monitoring wells located in an area suspected of having UXO, CSM or other hazardous waste are surveyed in a correct and safe manner.
2. A static walk through will be done during the EHSI mobilization period to get a baseline on the material being used and to familiarize all field personnel on the procedures to be used and answer any questions that may arise.
3. The following steps may not be all inclusive as situations will change at each work site (i.e. types and sizes of suspected ordnance, impact range, demolition range, demolition range with shots that were buried), but these steps will help the team get off on the right foot with the capability to adjust the procedure without compromising safety.
4. Remove all magnetic materials from your body. Remove the MK 26 from its carrying case and using the MK 26 manual (if required) assemble the unit in the bore hole configuration. Insure all threaded connections are clean and all covers or plugs are in place, the assembly should be accomplished in a clean area not out in the field. Be sure that the batteries are up at a minimum to 95% and the safety line is attached correctly.
5. During all downhole operations the correct size PVC will be on-site and immediately available, under no circumstances will the probe be lowered into the Monitoring Well/Boring/Hollow Stem Auger with out PVC. The following procedures will be followed when using the hollow stem auger. The hollow stem auger will be removed prior to conducting downhole operations.

WARNING

NEVER LOWER THE PROBE WITHOUT PVC INSTALLED

NEVER LOWER THE PROBE USING ONLY THE CONTROL WIRE

IF THE HOLLOW STEM AUGER CANNOT BE REMOVED HAVE AT LEAST 5 FEET FROM THE CENTER OF THE PROBE TO THE BOTTOM OF THE AUGER

USE A MINIMUM OF TWO MEN TO CONDUCT THIS OPERATION

A. Survey the surface location as required by the SOP.

A1. Survey depths will be dictated by the client

B. At 2 feet install the PVC till it bottoms out and record this depth, bring the auger to the surface move the drill rig a minimum of 20 feet, one technician will lower the probe using the safety line the other technician will watch the meter. If clear remove the probe and PVC, reposition the drill rig and continue the drilling.

C. At 4 feet install the PVC till it bottoms out and record this depth bring the auger up and out and move the drill rig a minimum of 20 feet repeat the same procedures as in "B" if clear continue drilling.

D. At 6, 8 and 10 feet the same procedures will be followed. If the area has a history as described in paragraph 3 of being used as a bombing range or a heavy impact range the above procedures will be used down to a minimum of 20 feet. (NOTE) There will be times when our last check will be at the 12 foot depth and even sooner, (i.e. undisturbed soil) this will be verified by the rig geologist and the EHSI Supervisor.

E. There will be times that common sense will dictate some of the actions, (i.e. normally the derrick can remain up, but if its on the side of a hill or uneven terrain it should be lowered), all situations are not exact, stop and address each condition as it arises, remember this is a team, utilize all the expertise available, if a contact is encountered notify the Site geologist and recommend moving the location.

F. If the ground is soft or on an incline some sort of track to get the drill rig repositioned will be required most installations have marshall matting around, a couple sections under the wheels will give the drill rig a temporary road bed for repositioning. If

the site has heavy contamination a back hoe may have to be used to install a PVC stick up. You may have to explain this to the FOL.

NOTE: An Access and Egress route will be surveyed for all surface Ordnance Explosive Waste (OEW), a 90 foot diameter working area will be surveyed at the Boring/Monitoring well location this may have to be larger if the drillers need some decon space, all attempts shall be made to put these work areas upwind. Pin flags will be used to show the areas that have been surveyed to work in.

NOTE: If using a hand augur the downhole procedures are to clear the surface, hand augur to 2 feet, clear to 4 feet "etc".